BELL TELEPHONE QUARTERLY

VOL. XV OCTOBER, 1936 NO. 4

THE SOCIAL IMPLICATIONS OF SCIENTIFIC RESEARCH IN ELECTRICAL COMMUNICATION

MORE TELEPHONE BUILDINGS

THE DEVELOPMENT OF DINING SERVICE AND OTHER QUARTERS FOR BELL SYSTEM WOMEN

THE BELL SYSTEM HISTORICAL MUSEUM

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BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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The Social Implications of Scientific Research in Electrical Communication*

IT HAS been suggested by those responsible for the program of the Harvard Tercentenary that as a conclusion to the discussions in fundamental science which have marked your deliberations for the past two weeks, it would be appropriate to consider some of the practical results attendant upon our attempts to utilize science in our industrial and social affairs. They have suggested further that some discussion of the efficacy of introducing the powerful tools of the research laboratory into industry might be in order and that recent advances in telephony would supply good illustrative material.

In accepting their invitation I must express my appreciation of the honor they have conferred on the scientific men of the electrical communication industry and on me in designating me as their spokesman.

By suggesting this sort of termination for the discussions, I assume that the Tercentenary Committee had in mind not only practical values of an economic kind but likewise practical values of a social nature. After all, unless we are clear as to the existence of social values and are prepared to appraise them honestly and be guided by the results of our appraisal, the dollars and cents values of our work are more likely than not to turn to ashes in our hands.

The purpose which the Tercentenary Committee had in mind could be accomplished by scrutiny of examples from almost any of the great modern industries which have developed on the foundation facts, techniques and methods of science.

* Excerpts from a lecture given in Sanders Theater, Cambridge, Mass., before the Harvard Tercentenary Conference of Arts and Sciences, by Dr. Frank B. Jewett, Vice President, American Telephone and Telegraph Company, and President, Bell Telephone Laboratories.

None of them, however, I think more completely exemplifies the present and prospective economic and social values of practical applications of science than does that part of electrical communication which we designate as telephony. Nor is there any other in which, so far as I am aware, the fundamental principles of the scientific method have been extended so greatly to control accurately, uniformly and continuously the operation of a vast human and material mechanism. This control is imperative if the service is to have that degree of reliability demanded by the requirements of a social and business society organized to a large extent on the assumption that satisfactory telephone service is always instantly available.

Factors in the Development of Telephony

Time does not permit any discussion in detail of how this has been made possible nor is there any necessity here of such discussion. All that need be mentioned is that among the principal factors have been a fortunate development of fundamental science itself in regions applicable to electrical communication; in an early appreciation of the power for advancement inherent in the slow but certain results of rigorously controlled experimentation, and in the almost equally early realization that in any community or region telephony must be a single service but one in which the physical means and human methods of operation are so chosen as to act harmoniously with the means and methods employed everywhere else.

Added to these and furnishing a rigid yardstick by which every new proposal must be measured is the fact that time is an all important factor. On its purely physical side, two-way telephony to be of value must involve essentially instantaneous transmission of intelligence between terminals; otherwise normal conversation would not be possible. Nothing which introduces substantial deviation from this requirement is admissible no matter how attractive it may be otherwise.

Further, every telephone circuit, whether it be between

terminals in adjacent rooms or between those separated by half or more of the circumference of the earth, must be a cleared channel established with minimum delay on demand in order that the correspondents be brought immediately vis-a-vis. On the operational side, therefore, time is also an essential factor and while it is inherently impossible to establish instantly any connection that may be asked for, everything that is reasonably possible is demanded to the end that every calling subscriber is served immediately on request.

In no other social service I am familiar with does the element of time play such an imperious controlling part.

A Service Rooted in Science

While there are still vast areas both in the science and operational regions where we know that great progress is still possible, we have already gone sufficiently far in our development of the art to have telephone service begin to take on the form of complete universality. With it have come marked changes in our methods of social and business intercourse, in our economic and political machinery and in the problems presented to our courts for adjudication. All of these things and their corresponding elements in other industries have their roots in science and whether or not we are conscious of it, it is the possibilities and limitations of this science root structure which in the end will largely determine the resulting form of our society.

So far have we gone already in perfecting the adaptation of science to the art of telephony that most of us when we use the telephone are not even cognizant, except vaguely perhaps, of the fact that our ability to talk freely wherever and whenever we wish is the result of an infinite amount of work by the men in the laboratory. We are not conscious of the fact that these men have been and are being confronted daily with myriads of problems—all obstacles of one sort or another. Some they conquer and eliminate—some they learn to control and utilize. In the end, they have produced a gossamer web of filaments

which, in spite of being beset with a multitude of enemies, they have succeeded in protecting and making available for its one and only function—that of enabling us to convey intelligible speech sounds to distant places. So effectively has this work been done that in many instances the men and women who install and operate the telephone plant are themselves unaware of the things done to make it smoothly operative.

The Underlying Problem of Education

This taking-for-granted attitude on the part of the many is common in every technical application of science to our daily usage. From it and from its corollary—action of a social, political or economic character with little or no understanding of the underlying and controlling forces—come most of our problems of proper social control of these new things. One of the biggest, if not the biggest problem ahead of us, is the educational problem of teaching a vast population, which is becoming more and more dependent on the things of applied science, enough of their inherent possibilities and limitations so that they can operate the social controls without danger of wrecking the machinery.

As one infinitesimal contribution to this educational problem and simply by way of illustrating in the field of telephony a few of the problems research men are solving every day in a multitude of industries, I shall give you a few demonstrations of things not normally observable when we use the telephone but which constitute some of the hidden factors I have mentioned. I shall begin by setting up a couple of telephone connections such as are regularly provided in the public service. This is merely to refresh your minds as to the results you obtain when you use the telephone. Except for the fact that you will hear through a loud speaking telephone, which for best results requires a transmission circuit slightly different from that ordinarily employed with a hand telephone, the result of one connection at least will be commonplace to all of you who

have occasion to employ the long distance telephone. The other, which will be a long distance conference call, may be strange to most of you although it is coming into somewhat general use in business operations. Then we will pick these or a similar circuit apart a bit and show you a few of the many hidden forces which the research man has either had to overcome or develop and control in order to give the operating people and you long and complicated circuits which apparently operate like short and simple ones. I shall endeavor also to show you a few of the odd things which our knowledge of science has enabled us to utilize in giving types of telephone service which would otherwise be impossible.

Finally, with the collaboration of Mr. Dudley, you will have a glimpse through the crack that the research man has made in the wall surrounding a hitherto undeveloped field in the realm of communication possibilities.

The Social Implications of Scientific Research

All of this is designed merely to give a springboard from which to project what seem to me a few plausible conclusions as to the social implications of scientific research in electrical communication and inferentially in many other fields as well.

Before going on to the demonstrations, it may be of interest to note briefly by analogy and otherwise what our present telephone facilities here in the United States really provide and some of the grosser effects which would result from their substantial annihilation.

Imagine direct railroad tracks from every city, village and hamlet to every other city, village and hamlet. Imagine a train on every track, steam up, ready to start at a moment's notice to any destination. Imagine the track facilities so ample that, no matter how numerous the trains, there are no delays either in going or returning. Imagine, further, that the trains move with incredible speed which in many cases is virtually that of light. Here we have in substance the achievement of

modern telephony when we realize that the cargo on the trains is human thought as conveyed by the spoken word. Recalling the words which Emerson wrote years ago at the completion of the first Atlantic cable—

> "The lightning has run masterless too long;
> He must to school and learn his verb and noun
> And teach his nimbleness to earn his wage,
> Spelling with guided tongue man's messages."—

how uncommonly prophetic these have proved! How well the lightning has learned his lesson.

Without the telephone, modern tall buildings and the correlated extreme density of populations in many of our urban developments would be either impossible or more encumbrances than aids to life and business. To carry by messenger the communications which enter and leave a tall office building by telephone during the rush hours, would block corridors and elevators and produce unprecedented traffic jams in the streets outside. For every person who walks along a busy city street, the telephone enables a much larger number to project their thoughts and personalities along the circuits below the street. Usually the telephone delivers a message and brings an answer in less than the time it would take to transcribe it for a messenger.

Merely to mention the number of calls completed each year over our American telephone system takes us at once into astronomical magnitudes. For the past year, the number was twenty-five billion. While the major portion of these were local calls, a vast number were long distance and, with added facilities and the prospect that through further research, costs can be lowered, there is every reason to believe that the time is not far distant when the number will be increased many fold.

When one attempts either by word of mouth or by demonstration to explain the recent problems of telephony and how they are being overcome, he finds that he has a uniquely difficult piece of work in hand. He must discourse upon a struc-

ture, the long telephone line, which neither he nor anyone in his audience has ever seen in its entirety, and he must, unless addressing a group of his own kind, put into words a host of concepts which find their proper expression only in mathematical symbols and processes or in the special language of the physicist. If I could transport you rapidly out across the continent three thousand miles or so, thus enabling you in the course of a few minutes to visualize what a complex thing a modern long distance telephone line actually is, I might hope to convey to you a superficial conception of the elaborate and fragile thing I am talking about. Only thus would many of you sense how remarkable it is that this frail far-flung structure should be endowed with surprising electrical stability and immunity to meteorological and man-made disturbances.

A Bird's-eye View of a Long Line

Were we to make such a flight, what actually would we find over and above the pairs of wires which every one recognizes as among the constituents of all telephone circuits—the wires which in one form, the open or exposed form, de Chavannes depicted in his painting in the Boston Public Library? We would find as a matter of fact, that these pairs of open wires represent a type of construction which is now rather in the minority even for long distance telephony. For reasons of better protection and stability, particularly in regard to electrical leakage, the wires composing even very long circuits are now frequently packed tightly together and enveloped in an impervious lead sheath to form a cable in which neutral gas, such as nitrogen, is maintained under pressure.

Continuing our imaginary flight, we would encounter on each of the hundreds of pairs of wires within each cable and at absolutely regular intervals varying from about $\frac{5}{8}$ mile to $1\frac{1}{8}$ miles on different circuits, a loading coil—a coil of wire on a special magnetic core whose function is to assist the speech currents, as they travel, to overcome the large attenuating

effect of the electrostatic capacity of the tightly packed wires. These coils, of which there may be as many as two or three thousand called into play in the handling of a single message, must be identical to a degree characteristic of the watchmaker's precision. Next, there is the repeated and uniform twisting of each pair of wires at its own particular pitch to secure such nicety of balance, both electrostatic and electromagnetic, that not more than a millionth of the power of a telephone circuit will pass over inductively to any neighboring circuit. Then at intervals of fifty miles for certain types of cables, and at shorter intervals—even as low as ten miles on certain newly projected types—we would encounter the thermionic amplifiers which restore the message energy after attenuation by resistance and other forms of dissipation. Closely associated with certain of these amplifiers are the regulators which automatically counteract the effect of changes in conductor resistance induced by changes in temperature. As an illustration of how important the regulators are, they must allow the total amplification of a long circuit to increase between winter and summer by as much as the factor 10^{20}. Then too there are the smaller diurnal variations which it is even more important to compensate for automatically because they are naturally of a very irregular pattern. The emergence of the sun from behind clouds or an icy blast along one section of a toll cable is registered almost immediately by a large alteration in the attenuation of the circuits within it. In case a cable is placed underground, the temperature changes to which it is subjected are of course of smaller amplitude and longer period, but for them too it has been found best to compensate on the automatic pilot wire basis.

In our overland flight we would actually see many other essential telephonic devices which cooperate to insure the steady and uninterrupted operation of the lines, but since our time is limited I must stop with the bolder details of the picture. I hope they will be sufficient to give you at least some visualiza-

tion of what science has enabled the telephone engineer to accomplish. So stable in operation is the telephone plant of today that in spite of the apparently fragile nature of its long lines, which in turn depend upon the uninterrupted functioning of many thousands of delicate electronic devices, it is available every hour of the day, day in and out. Along with growth in reliability despite an ever increasing dependence on delicate structures, has come a marked increase in the amount and scope of facilities as a result of the continually decreasing cost of circuits brought about by research. This combination of enhanced reliability, at cost sufficiently low to permit circuits to be provided in profusion, has made it possible for you to reach a distant party without leaving the telephone and has made operating delays a rarity rather than a commonplace.

To illustrate this point I am going to place one or two long distance calls. Even after thirty odd years' intimate association with telephone development, I still confess to a certain awe at the speed with which the telephone operators are today able to transport one about the country. In a sense, we are about to bring that painting by de Chavannes to life, and because I want you to hear with me how the girls operate the circuits I have arranged that whatever is audible on this telephone will also be reproduced by the loud speakers which you see here on the stage.

* * * * * *

[At this point Dr. Jewett talked by long distance telephone with Dr. Robert A. Millikan, in Pasadena, California, and then, over a conference circuit, talked with telephone officials in New York, Atlanta, Chicago, St. Louis and San Francisco.]

* * * * * *

So much by way of refreshing your minds on what normal telephone calls are like. I am now going to take a long circuit similar to those we have just used and perform some experiments with it merely to show you a few of the obstacles with

which the research men have had to contend in order to give us our apparently simple circuits.

It won't be practicable to have the circuit here before you because it is actually 1700 miles long and extends in cable from Cambridge to Charlotte, N. C., and back. You will have to take my word for it therefore when I say that it includes approximately 3000 loading coils, 40 equally spaced vacuum tube amplifiers, pilot wire regulators which control their gain to compensate for changes in temperature, and other devices, such as echo suppressors, the purpose of which I will return to in a moment. You will not, however, have to take my word for the curious phenomena which such a circuit exhibits—phenomena which are displayed best in a very long circuit—because with the aid of the loud speakers you will all be able to observe the circuit's performance when normal conditions of operation are disturbed.

The Telephone Line as an Integrated Entity

At the outset let me say a word or two as to a basic characteristic of long speech highways in which they differ fundamentally from other highways. The telephonic highway must respond as a single unit from end to end or not at all. It is a single entity, almost a living organism which, if disturbed at one point, reacts throughout. As a coordinated, balanced and self-contained unit, it is undoubtedly the most extended structure man has thus far built. Not like the highways for rolling stock which may be torn up for considerable sections without interrupting the flow of through traffic, we must consider the telephone line, even though thousands of miles long, as a single integrated entity. This characteristic underlies the demonstrations I have arranged.

Familiarity on your part with the general functioning of the vacuum tube, now indispensable as an amplifier in all forms of electrical communication, I must assume. We will pass on at once to consider the degree of perfection as regards accuracy

and stability to which the device has been brought in the telephone plant. As I mentioned earlier, I have here the terminals of a circuit 1700 miles long which is looped down to Charlotte, N. C., and which contains 40 amplifiers, each supplying an average gain rather greater than ten-fold. This gain is required since at each amplifier the speech current has been attenuated by resistance and other losses to about the value it must have at the receiving terminal. Further transmission without distortionless amplification would so weaken the current as to make it useless. A graph of current along the line would present a saw-tooth appearance—the value on reaching each repeater or amplifier being a minimum and beyond each amplifier being substantially that at the sending end.

Since the speech current passes through each amplifier successively, it receives this ten-fold boost at each so that after having passed the second amplifier the total gain is 10×10; at the third, it is $10 \times 10 \times 10$, and the total amplification from end to end of the circuit is 10^{40}, i.e. 10 with 39 naughts after it. Here indeed we are dealing with astronomical magnitudes. In terms of a more familiar physical quantity, this is multiplication about equivalent to taking a single atom of hydrogen, and magnifying it until it fills the entire solar system. Surprising as it is that such amplifications are attainable, it is even more unexpected to find them produced as an everyday affair with so little distortion that the final product at the receiving end is essentially indistinguishable from the original, and so perfectly under control that the overall variation in magnitude is negligible. Just to show that there is no perceptible distortion I will ask Mr. Thompson, one of my assistants, to enter the booth in the corner and speak to you, first directly through the loud speakers and then over the 1700 mile looped circuit.

* * * * * *

[At this point Dr. Jewett conducted various demonstrations to show the functions of the repeater, echo suppressor, speech

inverter and other equipment affecting the transmission characteristics of long circuits, which were followed by a demonstration of synthesized speech by Mr. Homer Dudley, of the staff of the Bell Telephone Laboratories.]

* * * * * *

These few demonstrations and all that we have told you are but minute examples of the results that have come from organized scientific research in the one field of electrical communication. Most of what we now have or of what we envisage for the future could not have been obtained except through rigorous application of the facts and methods of science in a broad frontal attack such as organized cooperative effort alone can make. It is not too much to expect that a continuation of the method will ultimately result in the substantial destruction of the barrier to conversation wherever and whenever desired which distance has imposed in the past. Since there is even now no physical obstacle of distance, this is simply another way of saying that a continuation of organized research gives promise of providing speech channels so numerous and relatively so cheap that the economic barriers to full usage will be obliterated.

A Complete Nervous System for Society

When this time comes, society for the first time in its long evolutionary history will through the varied forms of electrical communication have a complete nervous system. In many respects it will present striking similarities to man's nervous system. It cannot help but speed up what Spencer termed superorganic evolution and will in fact make possible a type of political state which could not develop without it.

Time does not permit any elaboration of the effects on society of this obliteration of distance as they influence the action and interaction of our human social atoms. My purpose here today has been served if I have conveyed to you some under-

standing of what scientific research in the communication field has already done and what it seems prepared to do in the future in the way of putting men everywhere in position to act with the same facilities, as regards interchange of ideas, as if they were in one room.

One could spend hours developing in detail the multitude of of ways in which the things evolved by organized scientific research in the field of electrical communication have influenced our modes of life. When all is said, however, the broad implications are to be found in the result just mentioned, namely, that through it we have already gone a long way toward providing society with a complete nervous system and have every prospect of finishing the job.

My purpose has been served further if it has given you a better idea of the vast power in coordinated research for solving incredibly intricate problems of a very practical nature and for developing adequate controls over multitudinous conflicting forces in such simple form that they can be operated easily by essentially unskilled people.

What organized scientific research has done and is doing in the field of communication is being repeated in a host of other fields. Everywhere there is growing evidence that the power inherent in the scientific method when applied to the prosaic affairs of everyday life is coming more and more to be understood.

The ever increasing flood of new tools which fundamental and applied science are giving us is obvious. So, too, are the initial results on society of their mass introduction into it. What is not so obvious are the processes by which they will gradually be fitted smoothly into an orderly society built up around them.

The one thing that is quite clear to me is that since these new tools are the direct result of operating a powerful method by skilled people, it is imperative if full social value is to be obtained that the method which produced them be extended

and that men and women be truly trained to apply it—not to produce new things but show us how properly to use them. In this it will not suffice to do what we have so frequently done in the past, feel that we are making progress by giving things awe-inspiring titles which serve merely to cloak shallowness of understanding.

To the extent, however, that we are able to introduce the elements of this proven method of rigidly controlled and co-ordinated experimentation into the stream of our social and political evolution, to that extent will we be able to simplify and expedite our progress.

FRANK B. JEWETT

MORE TELEPHONE BUILDINGS

THE BELL TELEPHONE QUARTERLY for July, 1929, contained an article, "Bell System Buildings—an interpretation," by R. S. Coe.

Enough was said and pictured to show that these modern buildings, planned to provide at reasonable cost for present service needs and for the continuing growth of telephone use, reflect in their character something of the Bell System's stability and its regard for the comfort and convenience of its customers and its employees; that they are planned to contribute toward the achievement of community ideals; that they exemplify the progressive spirit which has made possible telephone communication as it is today and as it will be in the years to come.

Ever since the publication of this article, many readers of the QUARTERLY have expressed an interest in seeing pictures of other buildings of the Bell System, whether or not of recent construction. It is to meet this desire that some selected photographs of typical structures are reproduced in the following pages.

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NEW YORK CITY, LONG DISTANCE

VOORHEES, GMELIN & WALKER, *Architects*

MONTREAL, P. Q., CANADA, BEAVER HALL

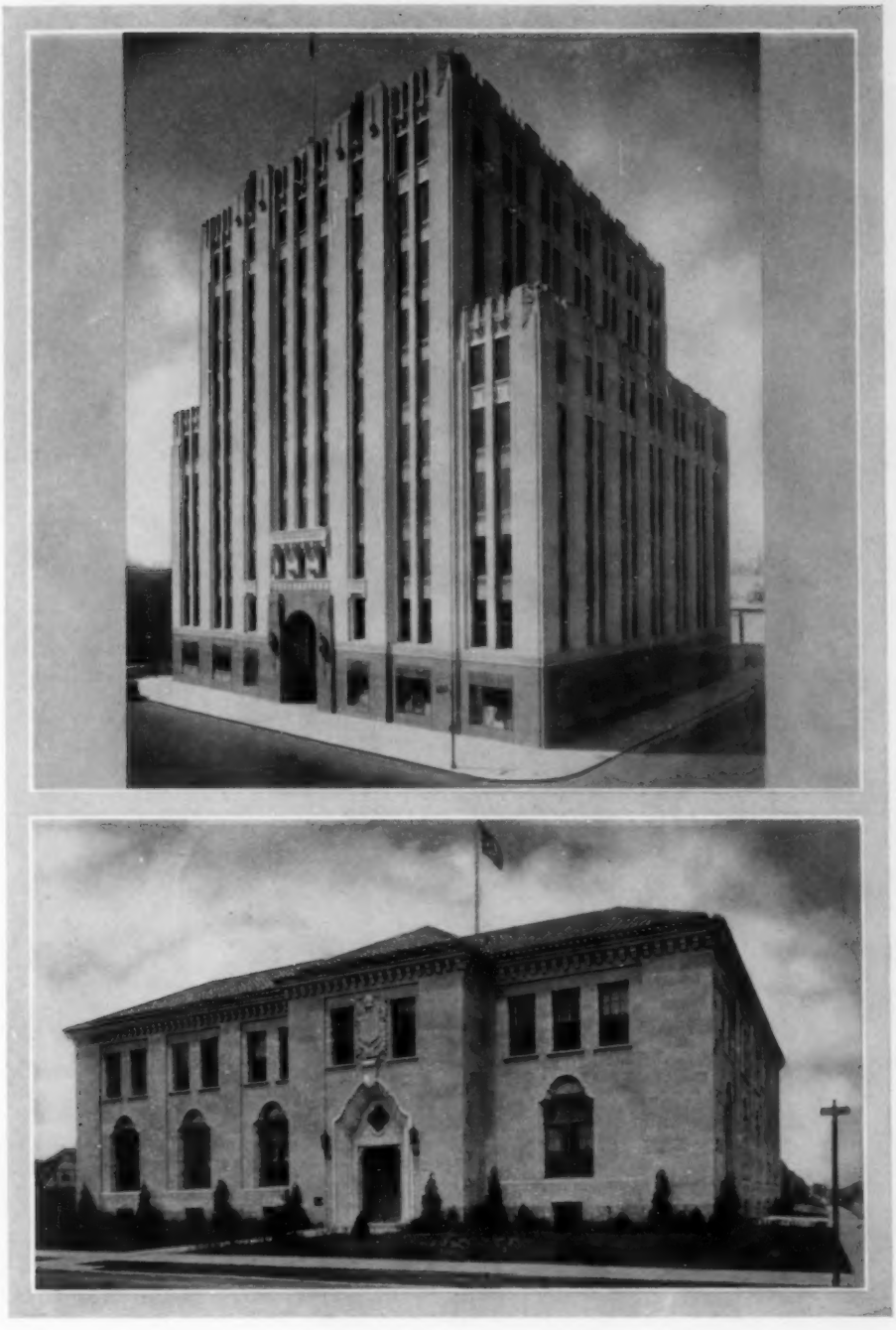
BAROTT & BLACKADER, *Architects*

DETROIT, MICH., HEADQUARTERS

SMITH, HINCHMAN & GRYLLS, *Architects*

MINNEAPOLIS, MINN., DOWNTOWN

HEWITT & BROWN, *Architects*



DAYTON, OHIO

SCHENCK & WILLIAMS, *Architects*

DETROIT, MICH., UNIVERSITY

SMITH, HINCHMAN & GRYLLS, *Architects*

LOS ANGELES, CAL., HEADQUARTERS

JOHN PARKINSON & DONALD B. PARKINSON, *Architects*

MILWAUKEE, WIS., LONG DISTANCE

ESCHWEILER & ESCHWEILER, *Architects*

SAN ANTONIO, TEX., DOWNTOWN

I. R. Timlin, *Architect*

KANSAS CITY, MO., LONG DISTANCE

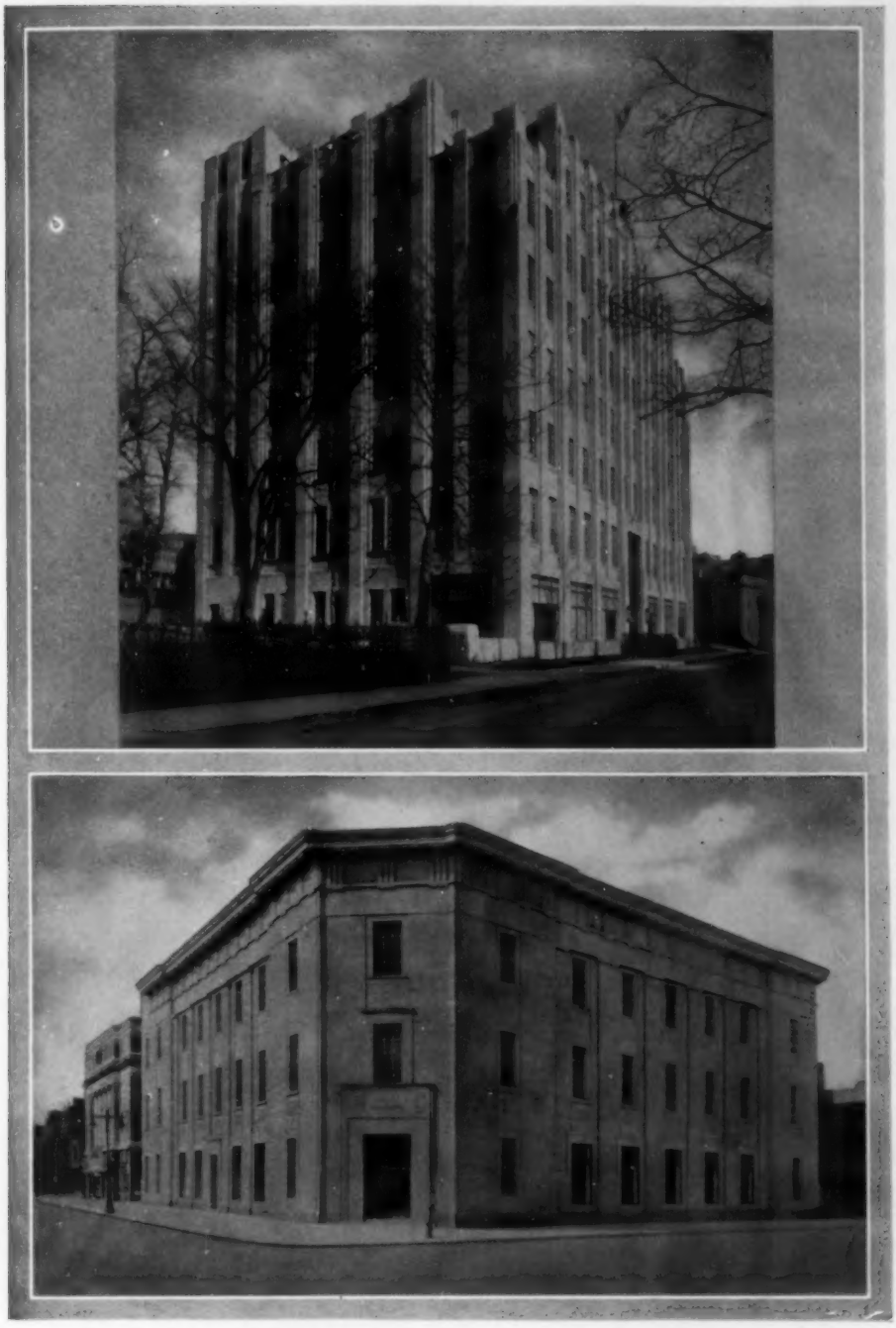
Hoit, Price & Barnes, *Architects*

CINCINNATI, OHIO, DOWNTOWN

HARRY HAKE & CHAS. H. KUCK, *Architects*

BRISTOL, CONN.

DOUGLAS ORR, *Architect*



WORCESTER, MASS.

DENSMORE, LECLEAR & ROBBINS, *Architects*

PHILADELPHIA, PA., SOUTH BROAD STREET

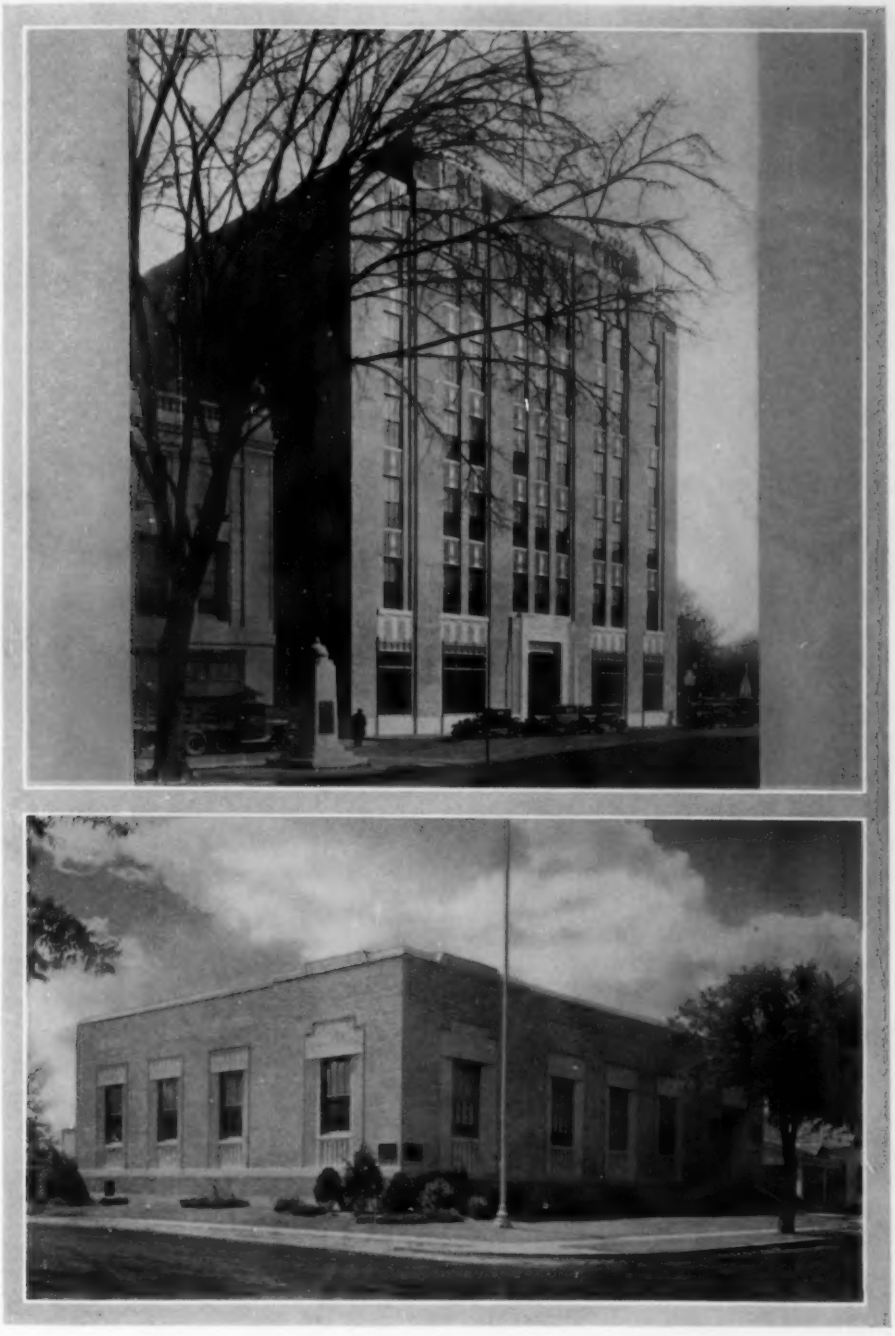
JOHN T. WINDRIM, *Architect*

INDIANAPOLIS, IND., HEADQUARTERS

VONNEGUT, BOHN & MUELLER, *Architects*

MILWAUKEE, WIS., SHERIDAN

FRANCIS S. GURDA, *Architect*

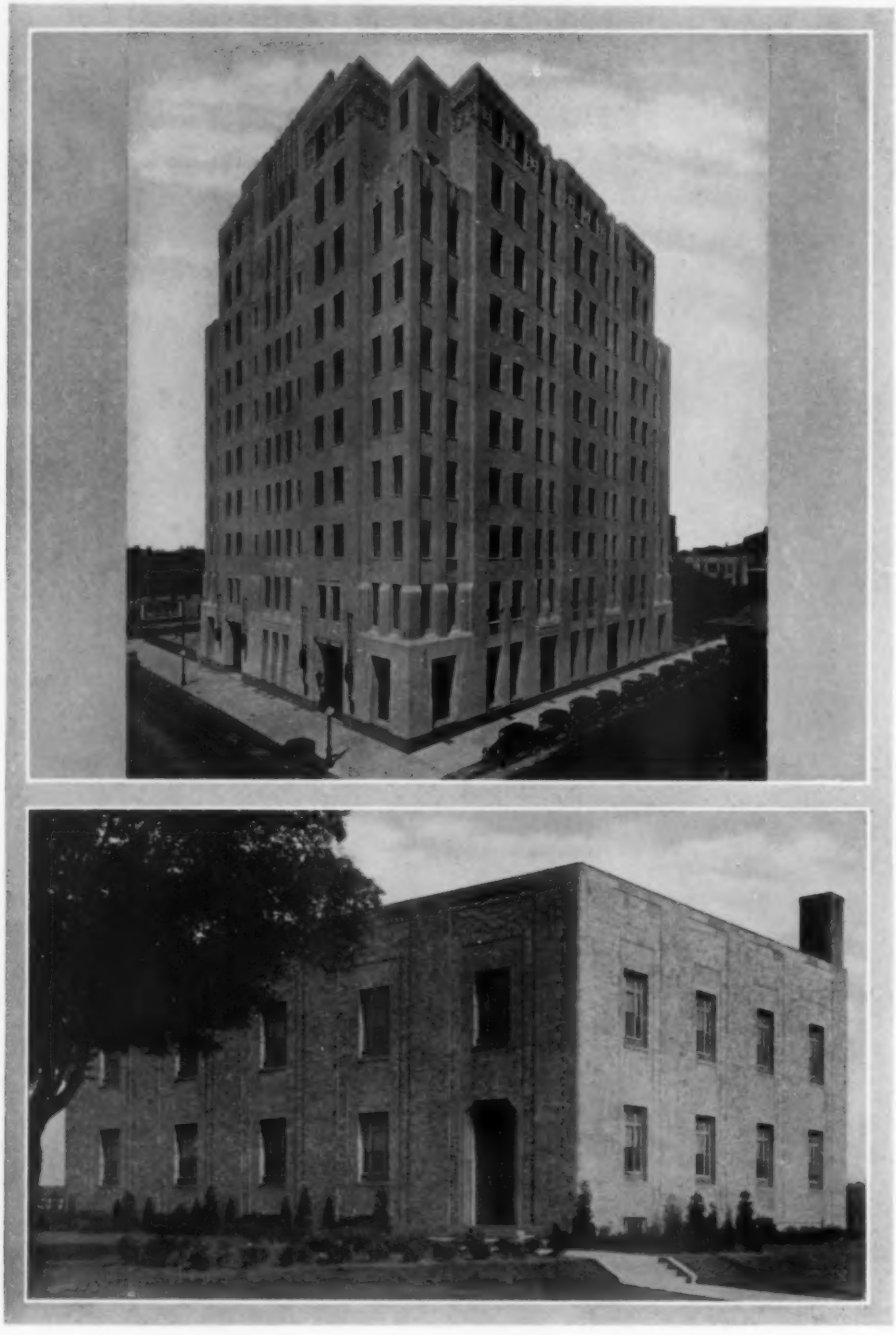


CHARLESTON, W. VA.

MEANOR & HANDLOSER, *Architects*

FORT WORTH, TEX., CHESTNUT STREET

I. R. TIMLIN, *Architect*

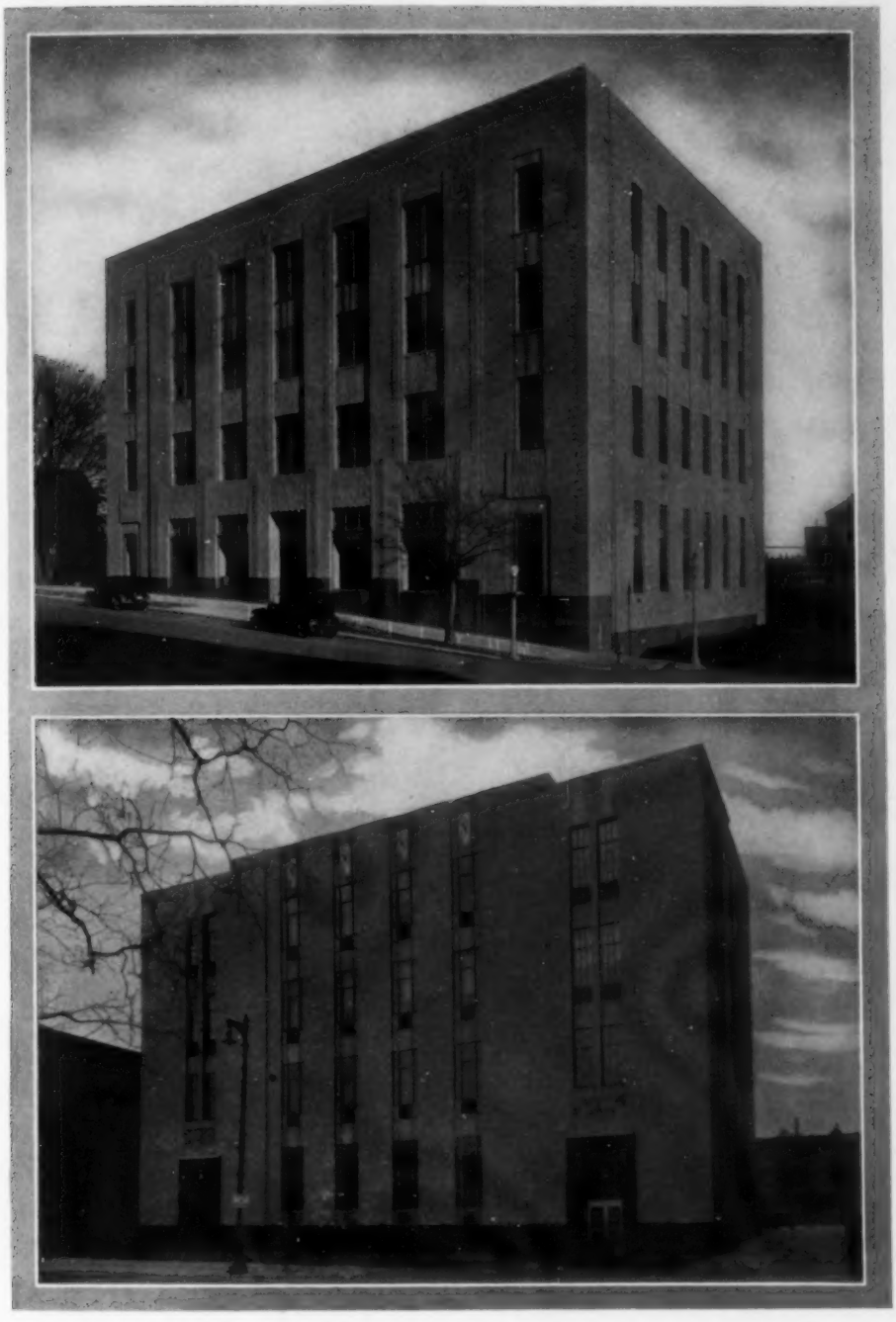


LOUISVILLE, KY., DOWNTOWN

MARYE, VINOUR, MARYE & ARMISTEAD, *Architects*

ELYRIA, OHIO, LONG LINES REPEATER STATION

MILLS, RHINES, BELLMAN & NORDHOFF, *Architects*

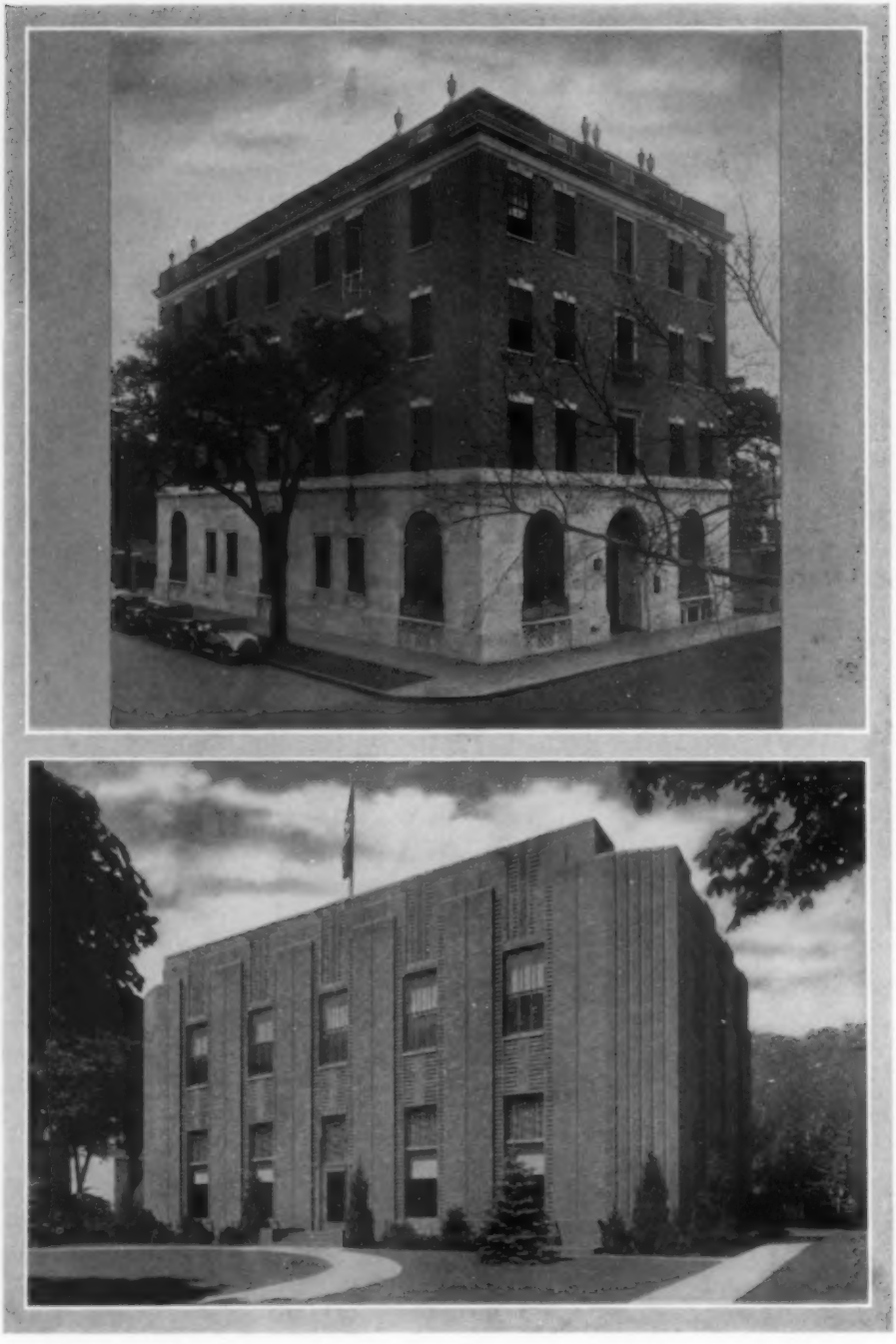


TACOMA, WASH.

BEBB & GOULD, *Architects*

CHICAGO, ILL., MONROE

HOLABIRD & ROOT, *Architects*



SAVANNAH, GA.

MARYE, VINOUR, MARYE & ARMISTEAD, *Architects*

ALBANY, N. Y., WESTERN AVENUE

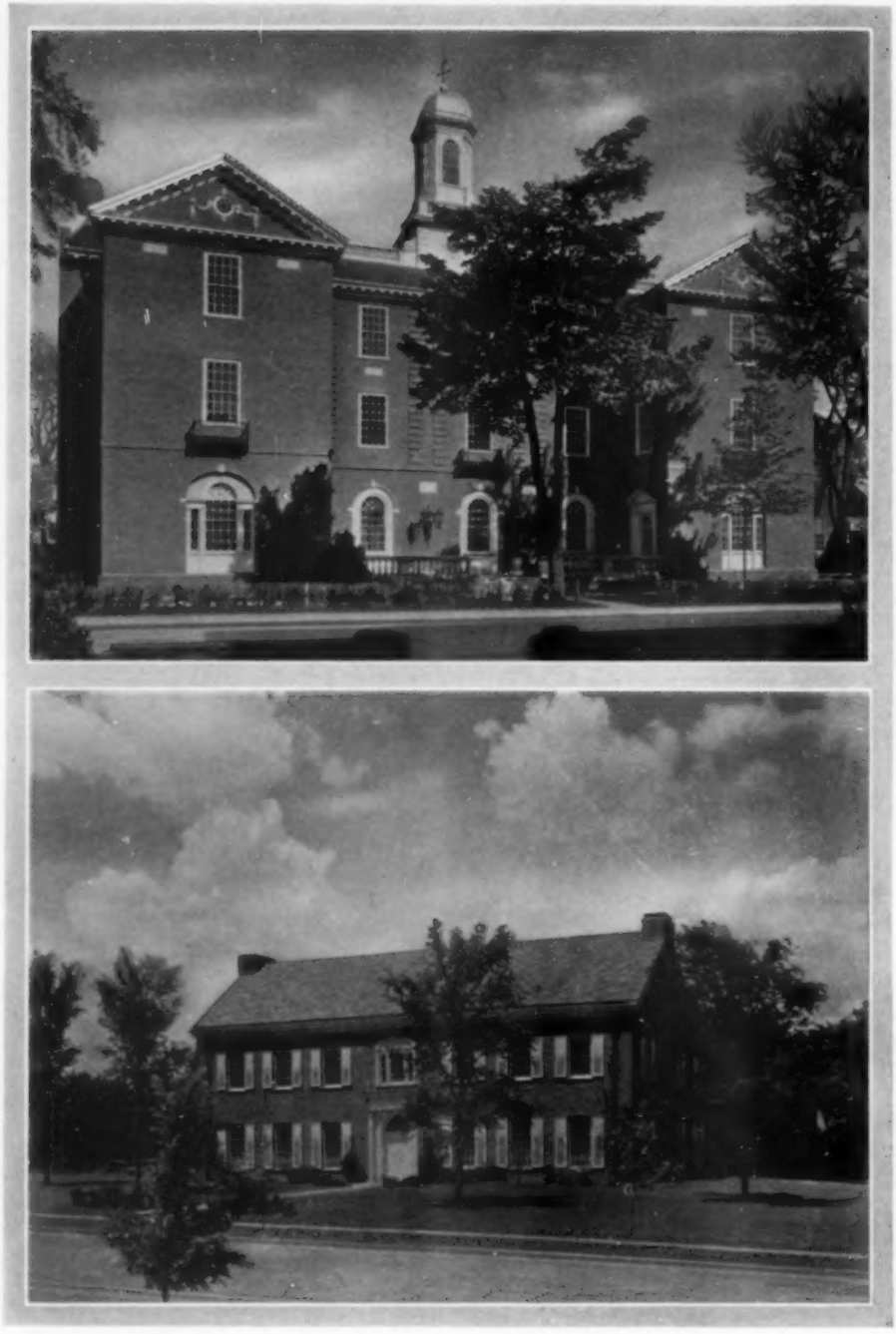
VOORHEES, GMELIN & WALKER, *Architects*

JOLIET, ILL.

HOLABIRD & ROOT, *Architects*

WASHINGTON, D. C., CLEVELAND–EMERSON

WADDY B. WOOD, *Architect*

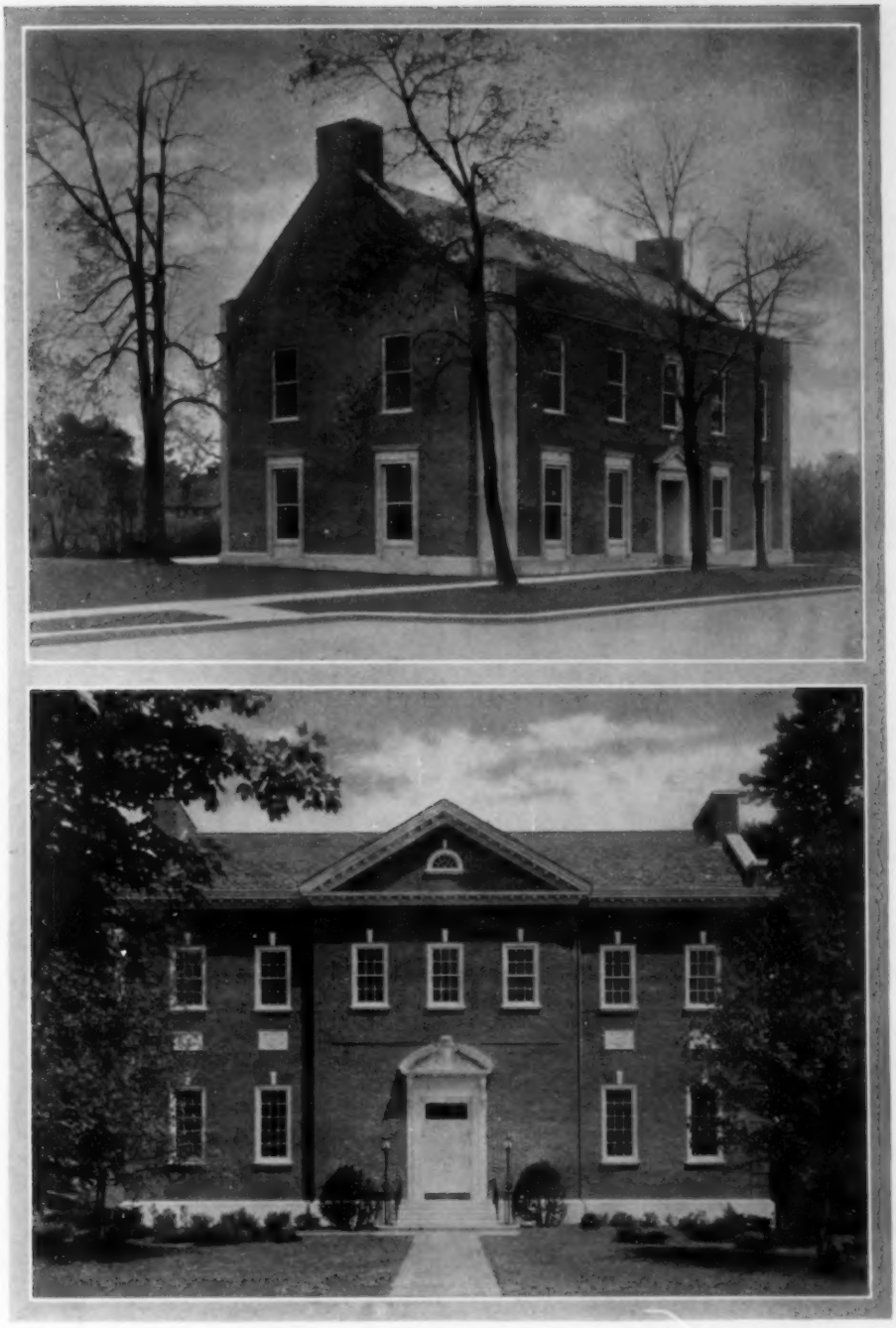


CAMBRIDGE, MASS.

DENSMORE, LECLEAR & ROBBINS, *Architects*

DES MOINES, IA., KINGMAN BOULEVARD

JOHN NORMILE, *Architect*



WINNETKA, ILL.

HOLABIRD & ROOT, *Architects*

CINCINNATI, OHIO, EAST

HARRY HAKE & HARRY HAKE, JR., *Architects*

TORRINGTON, CONN.

R. W. Foote, *Architect*

ATLANTA, GA., RAYMOND

Marye, Vinour, Marye & Armistead, *Architects*

WESTFIELD, N. J.

VOORHEES, GMELIN & WALKER, *Architects*

STATE COLLEGE, PA.

LAWRIE & GREEN, *Architects*

CHEYENNE, WYO.

W. N. Bowman, *Architect*

CLEVELAND, OHIO, CLEARWATER

Hughes & Conrad, *Architects*

HOLBROOK, ARIZ., LONG LINES REPEATER STATION

Fisher & Fisher, *Architects*

BOALSBURG, PA.

SHARON, MASS.

DENSMORE, LECLEAR & ROBBINS, *Architects*

JAMESPORT, N. Y.

OJAI, CAL.

G. R. MORRISON, *Architect*

The Development of Dining Service and Other Quarters for Bell System Women

THROUGHOUT the country, thousands of telephone workers, both men and women, come in daily contact with the Bell System's dining service for employees as they fill their trays with appetizing and wholesome food at cafeteria and sandwich counters, or make their selections from the more formal menus offered in the restaurants of some of the largest telephone buildings. Probably few of them, however, have an appreciation of the extent of this service or stop to think of the amount of planning required to provide the dining rooms and kitchens and keep the service functioning.

Bell System dining service, itself a very sizeable undertaking, is an integral part of the responsibility of furnishing telephone service to the public. Meals are furnished in 400 buildings of widely varying size. There are few really large dining service units: only 10 have receipts of $200 a day or more, while in 210 places receipts do not exceed $25 a day. The successful operation of a large number of small and medium sized dining rooms in scattered locations is perhaps the major problem. Lunches are served in all of the units, breakfasts and suppers as well in many places, and in the largest buildings food is available 24 hours a day. In addition to week day service, which is furnished in all of the dining rooms, meals are served also on Sundays and holidays in many places. Total receipts approximate $4,500,000 annually. Here is a self-contained business operated within the telephone business by telephone people and comparing in size and importance with the over-all operations of many outside concerns which are in the cafeteria and restaurant business as their sole endeavor.

The dining service to which telephone employees of today

are accustomed started from the simplest beginnings. The first so-called lunch rooms were installed to provide telephone operators with a place where they could eat the lunches which they brought from home. They could not make the journey to their homes and back again to the office during their lunch periods because of the distances, and in most cases there were no suitable outside eating places near enough to the central office for them to use. In those few locations where suitable outside places were within reach, difficulty was experienced by employees whose lunch periods came before or after the usual meal hours in obtaining food of good quality at such times. The need for providing lunch rooms in the buildings where the operators worked became obvious.

Service Is Extended to All Employees

At first, tables and chairs were provided. Later, gas hotplates were installed for the operators to use in preparing coffee and tea and for other light cooking. Then matrons were engaged by the Companies to wash the dishes; later, these matrons started to serve food and the menus were increased in scope. Some years ago, numerous requests from the employees led to the extension of the operators' dining service to include the female employees of the other departments and then the male employees. A still further development was the establishment of dining service in some of the headquarters buildings. Among other advantages, such service furthers friendly contacts between the employees of all departments, and also, as in the other buildings, is a great convenience to the employees, particularly in inclement weather.

In all of this work the American Telephone and Telegraph Company's headquarters staff has for many years been rendering important services to the Associated Companies. As the size of the undertaking increased, many and varied questions arose and numerous inquiries from the field were received. The situation was studied, and soon it was found desirable to

extend the facilities of the Department of Operation and Engineering to include the dining service job. The scope of this assistance is comprehensive and reference is made further on to many of the important matters covered. So that each Company will be in a position to profit by the combined experience of the System as a whole, the O. and E. Department of the headquarters company maintains close contacts with the dining service people all over the country. These contacts also extend to commercial cafeteria concerns and manufacturers in the equipment field.

The dining service is operated almost entirely by the Traffic Departments of the Operating Companies because it was started for the operators and continues to receive its greatest use by the female operating forces. In the smaller cities, the Chief Matron, meaning the employee in charge of the dining room, reports to either the Chief Operator or the District Superintendent of Traffic. In the large cities, the operation of the dining service, as it developed, became complex, and dining service departments have long been established. These departments supervise the operations in all the units, sometimes including those in the smaller cities of the same area or company.

Definite Objectives Are Established

In operating the dining service, there are definite objectives or aims which the managements strive to accomplish. These pertain to the service furnished and to the costs. It is aimed to render a service which is liked by the employees who are served. This includes the types of foods offered, the daily variety and quality of the food, the promptness and grade of the service, the cleanliness of the quarters, and the other features of a food serivce which the customers of any cafeteria or restaurant consider important.

In the early days there was a wide variety of practices as to costs. In most cases food was charged for; in a few instances

there was no charge. Beverages were furnished free in some cities; in others they were sold. Practices are now practically uniform throughout the System. The free service has been discontinued because it was found that employees preferred to get the money as wages and spend it in their own way. Generally speaking, prices are fixed at approximately the levels which apply in local commercial cafeterias serving food of comparable quality. The dining service, of course, is not operated to make a profit for the companies, though it might seem that if outside prices were approximated and the managements were efficient, a profit would ensue. However, in many cases dining service is furnished under conditions where it cannot be operated with full efficiency: in small places, and during off-hours and on Sundays and holidays in the larger places; and instead of a profit, a small deficit is unavoidable. In the commercial restaurant field, to ensure a good return, cafeterias are not operated under these conditions, but in the telephone business there is a particular need for such food services from the standpoint of working conditions.

Correlation with the Requirements of the Business

The operating problems encountered in meeting the objectives are, of course, those of a technical nature which any commercial restaurateur experiences, plus those of correlating the dining service with the requirements of the telephone business. A complete set of operating methods and practices, formulated by the American Company, was an important contribution in this regard. This material has been supplemented from time to time with many sets of suggestions relating to current problems. Also, numerous conferences on the subject have been conducted in various parts of the country and attended by representatives from all the Companies. The job in its entirety is being well handled by the many dining service people involved, and as a result the employees generally are proud of

"their dining room" and of the kind of service "their matrons" furnish.

When a new building is planned, conditions are studied to determine whether or not any dining service facilities will be required and, if so, what kind. In the smallest offices, where all of the operators go home for lunch, nothing is needed. In larger offices, where a few of the operators stay in for lunch, a kitchenette is provided, consisting of a small stove, refrigerator, sink, and dish cabinet, together with one or two dining tables and some chairs. The kitchenette is located either in a small room or in the sitting room (referred to later on) and screened therefrom. Where there are enough employees to warrant a regular meal service in the building, a cafeteria is provided. These cafeterias range in size from small units, with the kitchen, counter, and dining space combined in one small room, to large installations with a central kitchen and bakery supplying several cafeterias on different floors. In a few headquarters buildings, a sandwich shop also is provided, as well as a restaurant for those who prefer that form of service and are willing to pay for the additional expense involved. In all cases the arrangement must, of course, permit efficient operation during the peak serving periods, and also during the off periods, when the dining service force is reduced considerably in size.

Engineering the Dining Service Layout

The layouts are made by the Traffic and Engineering Departments of the Associated Companies concerned, frequently with their architects participating. On the more important projects, copies of the proposed plans and specifications are usually sent to New York for review by the O. and E. Department and frequent field trips are made by members of that group for the purpose of discussing the contemplated work with the engineers concerned. After completion, plans and photographs of many of the installations are obtained by the

O. and E. Department for such uses as may develop elsewhere in the System.

In addition to engineering dining service quarters for new buildings, an important part of the layout work is the remodeling of old quarters in buildings where the number of employees has changed considerably or where the equipment has worn out or new practices have been introduced. Sometimes it is a general rearrangement of the kitchen and counter; or a new dishwashing room with a modern washing machine, sink, and dish table; or a sandwich counter to permit making sandwiches to order—a recent addition to the facilities in numerous locations. The planning of these jobs requires care and oftentimes the details involved in making over an old installation are more difficult than when new quarters are designed.

As to the equipment, the amount provided varies, of course, with the size of the office. The objective is to provide adequately for the needs, but on the other hand to avoid purchasing equipment which is not required or which is too large. In selecting the equipment, many factors are involved, among which are safety, durability, ease of keeping it clean, and the cost. Appearance is also a factor, particularly where the equipment will be visible to the customers. Stainless metals are used for purposes where experience indicates the added cost to be warranted. Wherever possible, standard commercial equipment is used—ranges, refrigerators, dishwashing machines and so forth. Some items of equipment are not, however, available ready-made in the sizes required—counters, steam tables, range hoods, etc.; and these are specially constructed by contractors under Company specifications that define the requirements in detail.

In this layout and equipment work, including the furnishing and equipping of the other quarters mentioned further on, an "Operators' Quarters Engineering and Equipment Handbook" prepared by the Department of Operation and Engineering is used widely by the Associated Companies. This has been

available for many years, and, of course, is revised from time to time to keep it up to date. The Handbook has been a great help to the field people, particularly in many of the Associated Companies where there is not enough of this kind of work to warrant assigning a specialist to it. If a field man wants to know how much space ought to be provided for the kitchen or dining room, or what equipment will be needed in a cafeteria of a certain size, running all the way from ranges and dishwashing machines down to pots, pans, silverware and dishes, or how the major items of equipment should be arranged, he can turn to the Handbook and obtain the answer. If he wants to buy kitchen machinery or other ready-made articles of equipment, he can find out about types known to be satisfactory for his particular requirements. If the counter, cold pan, or other articles of equipment, not available ready-made, have to be fabricated, specifications are there covering the requirements in detail—types of construction, kinds and gauges of metals, etc. Any one in the restaurant business knows how long it takes to acquire adequate knowledge about these matters and how invaluable a complete treatise on the subject must be to one whose main experiences have been along other lines.

Furnishing the Dining Rooms

In furnishing and decorating the dining rooms, due consideration has been given to such factors as appearance, practicability, and cost. Women do not like heavy furniture. Adaptations of the early American type of tables and chairs seem to be preferred and are in common use. In some of the most recently furnished rooms, furniture with modern lines has been used. The top of the table presented a problem. Numerous types were experimented with; some were noisy, some broke easily, some showed scratches and the marks of hot plates. Linoleum in various colors was finally recommended to the Associated Companies as being the most all-around satis-

factory material for the purpose. Bell System dining rooms were among the first to use this type of table top, which to-day is favored by many commercial and industrial cafeteria and restaurant operators in all parts of the country. The dining room chairs are equipped with combination rubber and metal slides to reduce the noise. Some of the largest dishwashing rooms have been sound-proofed.

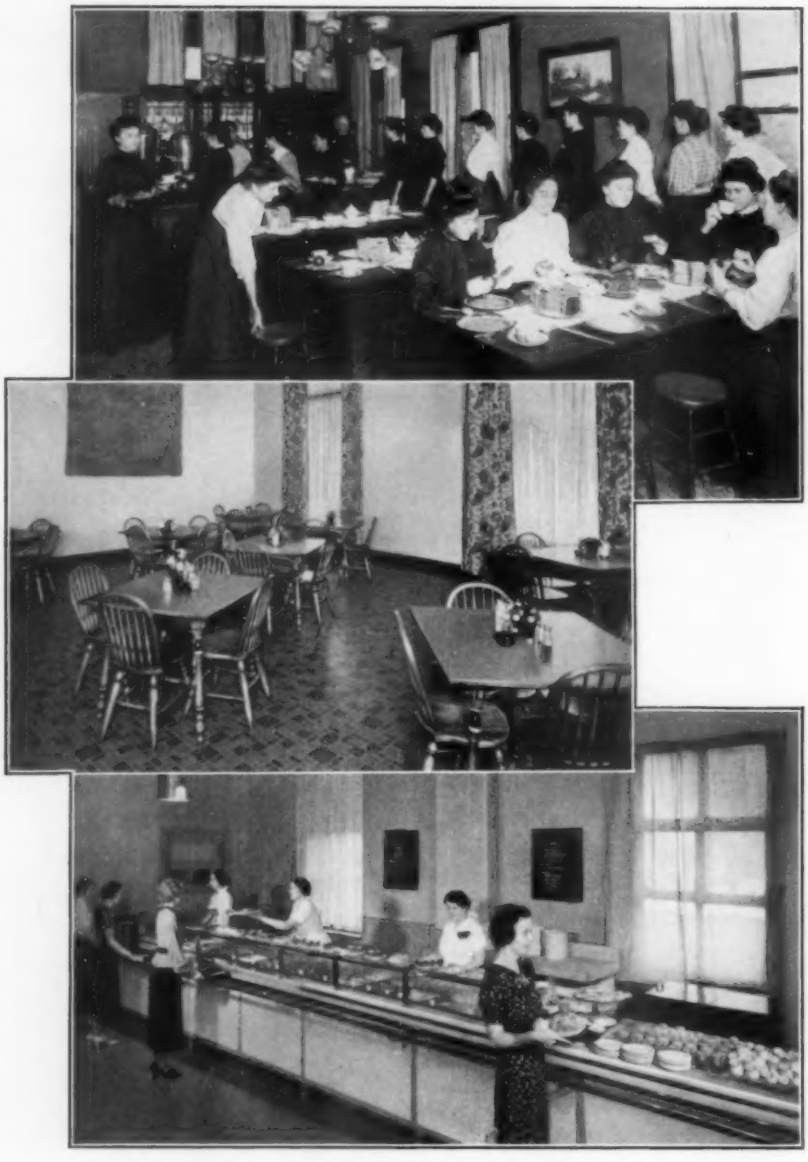
The foregoing provides a general picture of the engineering side of the dining service undertaking and, as will be seen from the photographs, the modern telephone building cafeteria, with its well equipped kitchen, counter, and dining room, presents a striking contrast to the lunch rooms which preceded it in the early days.

The Problem of Pleasing Many Tastes

Now let's return to the operation of the service. How about the food? It has been said that one of the principal aims is to please the employees who use the service. Strange as it may seem, certain items of food that are popular in one cafeteria may not sell well in some of the other cafeterias in the same city. When this is noticed, the quality of the cooking is first checked to see whether or not the food is being prepared as well in one place as the other. If this is not the reason, it may be that the employees in one office come largely from families that have been accustomed to different types of food from those in another office. Sometimes the particular cause just cannot be determined. And so, the first step in deciding what to serve is to consider what has been learned about the tastes of the customers in the particular cafeteria involved. Further, suggestions from the employees are always welcomed and, whenever practicable, they are acted upon and with a minimum of delay. Due regard is also given to planning wholesome food combinations. Another factor in arranging the menus is the number of meals to be served. Where the volume is small, the variety is necessarily limited. In the large

Above: In the "Tea and Coffee" Days.

Below: Modern Kitchenette Facilities in a Small Central Office Building.



TOP: A CENTRAL OFFICE LUNCHROOM IN THE "GAY NINETIES."
CENTER: A TYPICAL PRESENT-DAY DINING ROOM.
BOTTOM: ALONG COME THE CUSTOMERS.

Top: A Headquarters Building Kitchen.

Center: An Orderly and Sanitary Storeroom.

Bottom: Dishwashing Equipment in a Large Building.

Above: One of the Service Restaurants.

Below: Modern Cafeteria Facilities.

cafeterias and restaurants, a wide choice is offered. Market conditions have to be followed closely, so that the menus will include foods which may be purchased at particularly favorable prices at the time.

Food supplies are usually bought locally in each city. The centralized purchasing of foods on a System-wide basis has been studied on several occasions, but the plan was not considered feasible. Needless to say, the food standards are high. The buyers are careful, however, not to pay premiums for differences in grades which are technical in nature and not worth paying for as far as the finished item of food is concerned.

Tested Recipes and Portions

The Telephone Companies have a reputation for serving food that is tastefully prepared and attractively served. This did not come about by chance. Good raw materials and good cooks and bakers are obviously essential; but in addition, specific standards have been established. In other words, it is a common practice to supply the cooks and bakers with a set of recipe-portion cards which cover each item of food completely. When the need for such information became generally recognized, it was found that many of the Associated Companies had no qualified employee available for the tedious task of preparation involved. A set of cards covering 450 different dishes was, therefore, compiled at staff headquarters. A competent dietician with practical telephone company dining service experience developed the instructions, using the facilities of one of the central office kitchens in New York City, and each item was carefully prepared and checked before a decision was reached. These cards were then sent to the Associated Companies for such use locally as seemed desirable. As was expected, revisions have been made from time to time to fit local conditions, and new dishes have been added. Many valuable suggestions in this regard have come from cooks and bakers who are on the lookout for new dishes that might be served

and for better ways of doing their particular jobs if they can be found. The cards also cover the size of the portion to be served for each item. Obviously, there could be a considerable loss, as well as dissatisfaction among the customers, if the many thousands of portions which are served daily were carelessly measured. This method of control is standard in the chain restaurant and cafeteria field.

Appealing to Eye and Palate

The appearance of the cafeteria counter is a matter that has received due attention. While there is no attempt to sell the employees food they do not want, there is the same care in displaying the food properly as in preparing it. The counters are equipped with steam tables and glass display cases. The covers are removed from the steam table containers during the busy periods so that the food may be readily seen. Glass protectors in front of the steam table protect the food, while at the same time permitting a view by the customers. In arranging the food at the counter, the attendants have been carefully instructed as to the desirability of an attractive arrangement and how it may be obtained. A serving technique has been developed which is intended to make the serving of foods efficient and pleasing. It has been the aim to have the dining service forces develop a "customer" attitude toward their fellow employees on the other side of the counter.

Perhaps it would be interesting to take a quick look behind the scenes in one of the large cafeterias to see just what goes on. Here is the kitchen door. Supplies have just been brought to the kitchen floor on the elevator near the entrance into the kitchen—crates of lettuce, baskets of tomatoes, a bunch of bananas, several bags of potatoes and other items direct from the wholesale markets. Deliveries are checked and perishables are put away promptly in one of several "walk-in" refrigerators. When staple supplies are received, they are placed in the storeroom. This is equipped with sani-

tary metal shelves and covered bins for bulk supplies. A storekeeper is in charge of receiving and issuing all the supplies.

A Typical Day's Activities

The cooking equipment comes to view—a long battery of ranges, a deep fat frier, a broiler, steamers, and large kettles in which soups are made. The cooks have been busy since early morning and the noon meal is well under way. Several of the employees are seen preparing and assembling salads, using crisp lettuce, tomatoes, fruit and other appetizing ingredients. The bakery is in a separate room. All pies, cakes, biscuits and muffins are made on the premises. There are several large bake ovens, an electric mixer, a work table with bins below the top for sugar and flour. The bakers have their own refrigerator.

The supervisor's office is in one corner of the kitchen. Here the menus are planned, salesmen interviewed, bills checked, and other clerical duties performed.

Lunch time has nearly arrived. Prepared foods are being sent to the various cafeterias and to the restaurant. The quantities, however, are not large. The preparation of foods in large quantities is avoided in order to keep them fresh.

The cold pans in the counters have been filled with cracked ice. Salads and cold plates are being placed on the cracked ice; bottles of milk and other cold drinks are being imbedded in the ice. The steam table is receiving its supply of soups, meats, and vegetables. Sandwich ingredients are being placed in their proper containers at the sandwich counter. Fresh coffee has been made.

The attendants are at their stations with their spic and span uniforms, ready to render their usual prompt and pleasing service. Supplies of plates, cups, and glasses are within their easy reach. Here come the customers. Isn't it interesting to watch them size up the food, first this, then that, and finally, perhaps after receiving some friendly suggestions from the ser-

vers, make up their minds as to exactly what items they would like to have on this particular day?

Over there is the dishwashing room. Used tableware is arriving and the dishwashing machine is in use. First the dishes are washed, then rinsed, all automatically. Serving trays are being cleaned. Silverware is being polished in a machine designed especially for the purpose. There are no unpleasant odors; even the garbage is placed in a refrigerated vault as soon as the cans are filled.

Later, everything must be cleaned up. Then come the operators on afternoon relief. They pick up a snack and something to drink. Then suppers are served; then the night operators have their meals; then another day begins with the serving of breakfasts and a repetition of everything that has gone on before. The big majority of the meals are lunches, with a much smaller number of suppers and relatively few breakfasts, which are served to some of the night employees coming off duty and day employees on their way to work.

System-wide Reports Are Prepared

Most of the dining service employees are women. Many have had long years of service. Except in the case of a few of the specialized workers, the employees had no previous experience in the cafeteria field. Some work full time, others part time. Most of the part-time workers have other duties at home and find a part-time position most suitable to their needs. A very friendly feeling exists between the matrons and the employees served.

In operating the dining service, a careful job of cost control is involved. A cost report is prepared for each of the dining rooms every month. All of the operating costs, properly classified, are included, along with receipts and significant comparative data used for administrative purposes. Except in a few special cases, a uniform cost report is used throughout the Bell System. The standardization many years ago of this report

and the related practices was an important step forward in controlling the cost results of this extensive business. Copies of the reports are sent to the American Company monthly and from them are prepared and sent to the Associated Companies quarterly summaries showing the comparative results for each area and for the System as a whole. The dining service managements, in addition to watching their own costs, look forward to receipt of the summaries to see how their results compare with those of the other areas. In many cases, particularly in the larger cafeterias and during periods when food costs are fluctuating widely, food costs, receipts, and the relationship of one to the other are followed more closely, usually on a weekly basis. A "Food Cost Control" record is kept in the dining rooms. The results are compared with an objective and, if there are any important fluctuations, the reasons are determined. Possible causes of overruns are the use of materials that are too expensive at the time, waste in the kitchen, and carelessness in gauging portions.

The Dining Service in Emergencies

The normal operation of the dining service is one thing; its operation during periods of emergency is another. Take, for example, the situation in the Grant Building at Pittsburgh during the floods of last March. A recent issue of the Bell Telephone Company of Pennsylvania *Telephone News* supplies an interesting description of the conditions. Most of the meat and provision stores had been flooded out. The usual delivery service had stopped, but by private car and on willing shoulders of telephone men came hams, frankfurters in 100-pound lots, tubs of butter, crates of eggs, cans of milk, baskets of bread, and other needed supplies. The elevators were not operating and all of the food had to be carried up to the eleventh floor kitchen. When the kitchen water supply stopped, that too had to be carried.

After the cooks and bakers had finished their work, every-

thing had to be carried down again to the tenth floor cafeteria. Dishes were dispensed with in favor of paper plates and cups —the washing machine could not be operated. Everything had to be done by hand, and the number of employees to be fed increased rapidly. Emergency telephone service and desk space in the building were provided for railroads, bus lines, newspapers, food distributors and others rendering an essential public service. During the early stages of the emergency, these guests of the Company also shared in the commissary supplies. It was necessary quickly to increase the force of dining service employees. For some, sleeping quarters had to be provided in the building where they worked; for others, transportation facilities back and forth from their homes had to be arranged for. Food supplies were also prepared in this building and packed and transported to other buildings as the need arose. Included in one order was a call for 250 sandwiches. The dining service employees in all such instances, whether it be flood, earthquake, or other disaster, have been resourceful and untiring in their efforts to "carry on."

There are many pleasant interludes in the day-to-day activities in the dining rooms. Frequently, when operators leave to be married, their office associates arrange with the chief matron for the preparation of a special meal, with a party cake and other good things to eat. Tables are pushed together and decorated with crepe paper, flowers, and favors. Sometimes it is an anniversary for one of the central office employees, or a retirement party for another. The matrons like to participate in these affairs, which provide a pleasant change from routine duties, and they do everything possible to make each one successful.

Nutrition Course for Women

The Nutrition Course for Women also comes in the category of special activities in the dining rooms. This is an optional out-of-hours course and was launched in the Fall of 1929 to

supplement the already popular General Health Course for Women. Included in the Nutrition Course is considerable practical work in the preparation of food by the operators and other employees participating. Existing kitchen facilities in the telephone buildings are used for this purpose. The dining service people coöperate splendidly in this work and are glad to assist the instructors in the more practical features of the course. Many of the matrons have themselves taken the Nutrition Course. To date, approximately 1,000 classes have been held, with an enrollment of over 10,000 students. At the termination of the course, each class prepares and serves a meal in the dining room, partaken of by the students, instructors, and other employee guests.

All of the varied details of the dining service job—the planning of layouts, buying of equipment, hiring of employees, planning of menus, purchase, preparation and service of food, plus other necessary tasks—truly represent an extensive enterprise: the operation of a large chain of cafeterias in all its many phases, a fundamental working conditions activity that takes its place with numerous other activities of importance in the proper functioning of the Bell System as a whole.

The facilities provided for the female operating personnel do not stop with the furnishing of dining rooms. About the time the latter were installed, so-called rest rooms or sitting rooms were provided for the operators to use during the remainder of their meal periods after they had eaten, while on their 15-minute morning and afternoon reliefs, and at such other times as they are in the building and off duty. These rooms are provided in all but the very small offices. A visit to one of the large rooms usually shows some of the employees sitting around in small groups and "just chatting." Others are seen playing bridge, listening to the radio, telephoning, or reading books or magazines selected from the reading matter provided by the Company.

Development of the Sitting Rooms

The development of the sitting rooms and the changes which have taken place through the years have been as marked as in the case of the dining rooms. Many different types of furniture have been used: heavy "mission" furniture with leather covered seats and plain wooden backs, overstuffed furniture, willow furniture, and the present type of graceful wooden furniture chiefly of early American design, with loose seat cushions, loose pad backs, and attractive upholstery fabrics. This furniture is strongly made, though not too heavy, and is sanitary. Chairs and settees are provided in different sizes, so that all employees can find seats which are comfortable to them. The upholstery is usually in slip-cover form, which facilitates the required cleaning. Care has been exercised to provide the right atmosphere in these rooms; what is desired is a homey, pleasant room and one which is not overdone or ostentatious. The views of the employees are, of course, obtained and followed as far as practicable in the selection of the furnishings, particularly as regards color schemes.

These are the employees' "own rooms." They take pride in them and are careful to keep them neat and orderly. Other uses for the sitting rooms sometimes arise, such as a central office party or other get-together. During the holidays, Christmas trees are decorated by the girls. In some places they assemble baskets for the poor and invite children in for a celebration before the gifts are distributed. The employees take a genuine interest in all such activities, which undoubtedly are among the features that make telephone work as pleasant as it is.

In the medium sized and large offices, a so-called quiet room is provided for the use of female employees when indisposed. These rooms are equipped with one or more day beds, chairs, and other necessary furniture. A Bell System first aid cabinet is at hand, with a carefully selected list of standardized sup-

Above: One of the Early Sitting Rooms.

Below: Varied Activities Occupy Employees' Off Hours in This Comfortable Sitting Room.

Above: Employees Contribute Much to the Happiness of Others during the Holiday Season.

Below: Graduates of the Nutrition Course with their Instructor and Guests Enjoying a Meal Prepared and Served by the Class.

plies and the necessary instructions. The importance of being prepared to render first aid treatment to the employees in minor emergency cases—bruises, cuts, sprains, neuralgia, toothache, etc.—has long been recognized in the Bell System. However, prior to the adoption of the present arrangements, there was a considerable variation in the practices, and some were better than others. The standard cabinet, supplies, and instructions were developed under the supervision of the Medical Director of the American Telephone and Telegraph Company and embody the most suitable practices for the purpose. Only such remedies and directions are provided as can be safely used by lay people in the absence of a physician. To aid in insuring an adequate supply and also a systematic arrangement of the containers, the inside back of the cabinet is printed to indicate the proper contents of the cabinet and the intended location for everything. The instructions are attached to the inside of the door. This emergency cabinet is also provided in many offices that do not have a quiet room. In the very smallest places, a simplified stock of supplies is kept by the Chief Operator.

In the locker rooms, metal clothes lockers, adequately ventilated, are provided. Umbrella racks, with a locking compartment for each umbrella, are available in the larger offices.

The sitting, quiet, and locker rooms are shared generally by the female employees of all departments, except that in the largest buildings separate rooms are provided for different groups of people.

Operating costs of the sitting, quiet, and locker rooms are reported on a uniform basis. Copies of the reports are sent to New York regularly, and summaries are supplied to the field showing the comparative results.

And thus the story of another of the many diversified and interesting phases of Bell System operations is told. At one time the Bell Telephone Companies were among the very few concerns that provided dining rooms, rest rooms, and other

quarters for their employees. Now, the desirability of good working conditions is recognized in industry generally, and many other employers are doing the same thing. However, as was to be expected, the Bell System has kept up to date in this field also, and, as in the early days, is still a leader in providing wholesome and attractive working conditions for its employees.

R. A. STEELMAN

The Bell System Historical Museum

(*Continued from the July, 1936, Issue*)

Telephone Switchboards

The development of the telephone switchboard proper occupies one corner of the museum adjacent to the central office apparatus exhibits. There is a case of very early switchboards shown in Figure 11. Some of the early switchboards exhibited on the floor as well as groups of photographs depicting manual switchboards through the years to the modern panel type central office are shown in Figure 12.

At the top center of the case, Figure 11, is the original first telephone exchange switchboard. It was designed by E. T. Holmes, who conducted a burglar alarm system in Boston, and was built by Charles Williams. Box telephones were installed in the offices of some of the subscribers to the burglar alarm system and were connected to this switchboard over the burglar alarm wires. Signaling was effected in both directions by the burglar alarm apparatus. The lines were first placed in service on May 17, 1877. The switchboard, however, was later discontinued because the subscribers were not willing to pay for a luxury, as the telephone was then considered. It was the first switchboard to be used to interconnect telephones installed in different buildings.

On the following January 28, 1878, the first commercial telephone switchboard in the world was opened for regular service in New Haven, Connecticut. It was designed by George W. Coy. A model of this board and two subscriber sets are on display at the rear of the Museum. In Figure 11 immediately below the Holmes switchboard, is the original switchboard and calling annunciator installed in Meriden, Connecticut, January

31, 1878. It was the second commercial switchboard in the world to be placed in service. It was designed by Ellis B. Baker and follows closely the pattern of the New Haven board. In both these early switchboards, the subscriber set (see Figure 7), consisted of a push-button to call the central office and a wooden hand telephone, used both as transmitter and receiver. The signaling arrangement at the switchboard to call the subscribers consisted of a "Watson buzzer" or a "Coy's chicken," as it was dubbed at New Haven. A vibrating spring interrupting a current amplified through an induction coil caused the diaphragm in the hand telephone at the subscriber's station to howl. Thus the subscriber's hand telephone at first had three uses—transmitter, receiver and signal. The operator's set was also a hand telephone.

Immediately to the left and to the right of the Holmes switchboard are the first and second switchboards installed in Philadelphia in 1878 and 1879, respectively. They were made by Williams of Boston and are essentially telegraph peg boards adapted for telephone switches. The Philadelphia telephone people were former telegraphers and preferred this type of board to the New Haven type with its lever and stud connections. The square board at the right of the Meriden board is an early Detroit switchboard designed in 1879 by W. A. Jackson, who later became president of the Michigan Bell Telephone Company.

To the left of the Meriden board is the Western Electric Company's universal telephone switchboard of 1879, the first switchboard to be made by that company. Among other features, it used the Scribner jack knife switch, and had plugs attached to cords for both answering and calling. The operator's set consisted of the Brown handset of 1879. Other smaller switchboards in the case are of the Williams type peg boards, a section of a Gilliland board, a Watson slide switch and others, practically all of them based on the telegraph type of cross-connecting switchboard.

In Figure 12 at the left is shown the original Golden, Colorado, Gilliland switchboard installed in 1880. Underneath, in its temporary location, is a unit of carrier current equipment used in the first commercial multiplex telephone and telegraph lines installed between Tuxedo, Maryland, and Brushton, Pennsylvania, for the Washington-Pittsburgh service in 1918. At the right of the photograph is shown a section of the Lorimer system of machine telephony that was in use to a limited extent in 1906. Other switchboard exhibits nearby, not illustrated, are a section of the Law multiple switchboard at St. Louis, Missouri, installed in 1880; a quaint hotel switchboard used in the Stewart Hotel, San Bernardino, California, in 1881; and a hand-made switchboard used in Montfort, Wisconsin, in 1898.

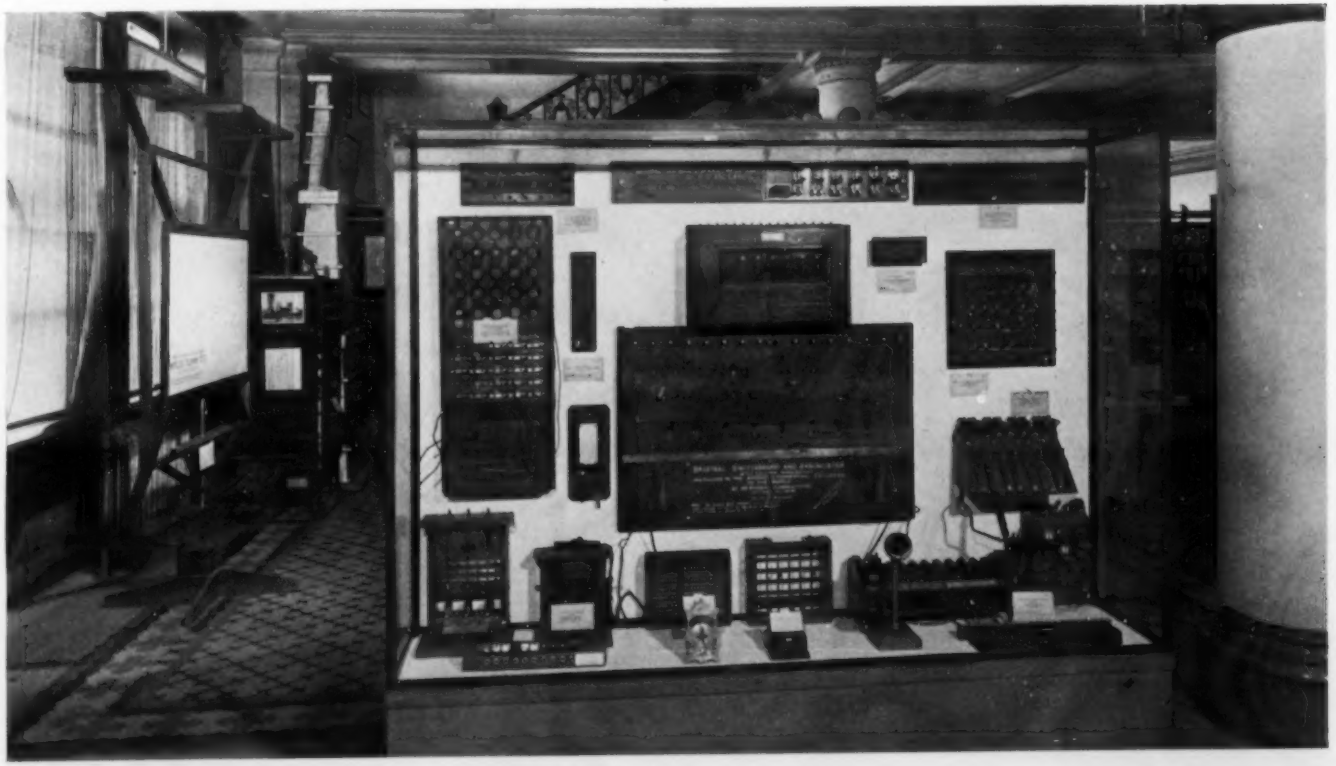
In the museum files are photographs of a very large number of switchboards, illustrating their continuing development. On display are found photographs of some of the more important types, as shown in Figure 12. In the large panel these include, among others, the first switchboard at New Haven, Connecticut, 1878; the Gold and Stock exchange at New York, 1879; Bridgeport, Connecticut, 1878; Portland, Maine, 1885; a Charles Williams, Jr. spring jack central office switch installed in Montevideo, Uraguay, in 1882 and still giving service as late as 1920; the Cortlandt, New York, branch terminal board of 1887; the Terre Haute, Indiana, board of 1897; North Office, Chicago, 1900; Canal Street, New York, manual A board of 1928 and the dial A board for the Worth and Rector panel exchanges, New York City, 1931. On the walls, beginning at the left, we see photographs of the first common battery exchange at Lexington, Massachusetts, December, 1893; the first common battery multiple switchboard at Worcester, Massachusetts, 1896; at the right the first semi-mechanical exchange at Newark, New Jersey, January, 1919; and a part of the equipment of the first full automatic panel system cut into service in Omaha, Nebraska, December 10, 1921. Other photographs

not shown include views of the Telephone Dispatch Company's central office in Boston in 1883 and Law type switchboards in Richmond, Virginia, 1882, and Lynchburg, Virginia, 1898.

Early Developments Not Associated with the Bell Organization

So far, we have followed sequences of development somewhat in the order of their introduction in the telephone plant. Let us now view the collection of early developments of other early workers, who, at the time, were not associated with the Bell organization.

The early work of Thomas A. Edison with his carbon transmitter is shown by over two dozen different models, most of them originals, from 1877 to 1880, and some of which show improvements by Scribner and Phelps of the Western Electric Company. There is a shelf devoted to originals and models of the Emilie Berliner loose contact transmitters of 1877 and various modifications made during 1878. Another shelf is occupied with models of Elisha Gray's liquid transmitter of 1876 and various forms of transmitters and receivers designed by him in 1877 and 1878. Several examples of transmitters and condenser receivers designed by Amos F. Dolbear are also shown. Examples of the work of these men appear in Figure 13. Then, there is quite a large group of models of telephonic instruments that were made in connection with the extended litigation of the Bell patents to illustrate to the courts how these instruments were supposed to operate. Among these are models of the Reiss transmitters and receivers of 1861, '62, '63; Wrentheim rods of 1863; House transmitter of 1868; Van der Weyde's, Drawbaugh's, Voelker's and Randall's transmitters of 1879. A discussion of the claims put forth in favor of these instruments does not fall within the scope of this article. There is also a group of about 100 different infringing telephones collected by the Bell Company during the period of liti-

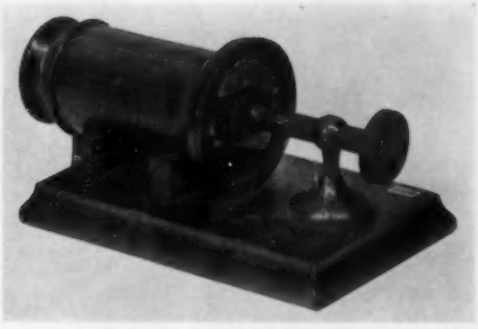


Group of Early Switchboards.
FIGURE 11

Early Switchboards, and Photographs of Multiple Switchboard and Dial Switching Developments.

FIGURE 12

Model of Gray's Liquid Transmitter: 1876.



Edison's Experimental Apparatus for Using Lamp Black in Transmitters: 1877.

Sample of Dolbear's Condenser Receiver: 1880.

Model of Berliner's Loose Contact Transmitter: 1877.

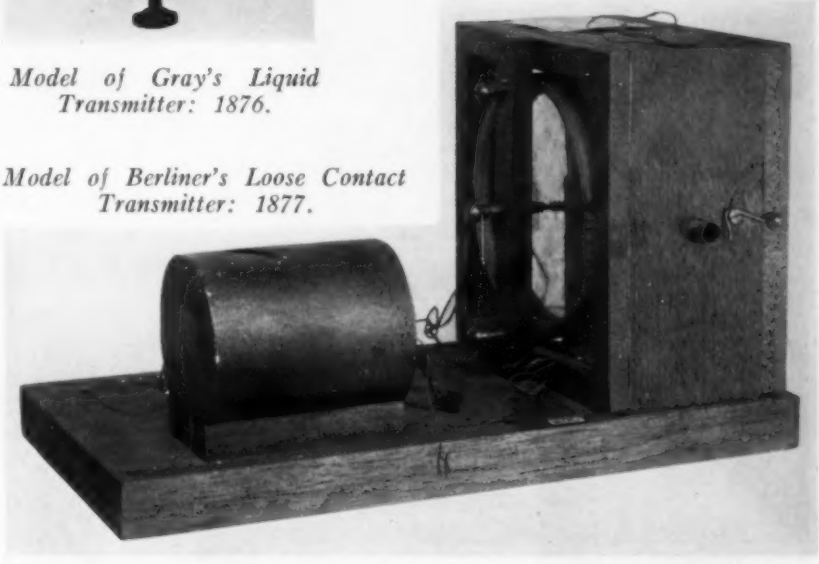
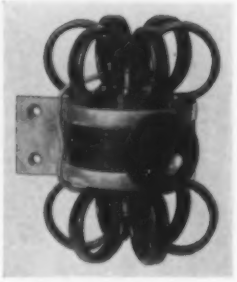


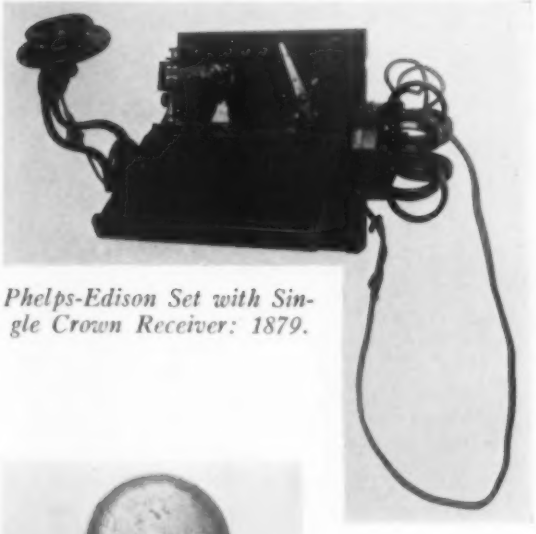
FIGURE 13



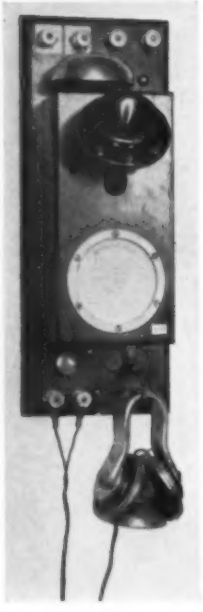
Phelps Double Crown Telephone: 1879.

Gray's Battery Telephone: 1879.

Phelps Pony Crown Telephone: 1880.



Phelps-Edison Set with Single Crown Receiver: 1879.



Chicago Set with Gray's Bipolar Receiver: 1879.

Large California Edison Set: 1879.

Phelps Long Line Magneto Box: 1879.

FIGURE 14

gation and used as exhibits in court cases during the many actions brought in defending the Bell patents.

The American Speaking Telephone Company's Apparatus

The Western Union Telegraph Company, through its subsidiary the American Speaking Telephone Company, organized in December, 1877, and the latter's agent, the Gold and Stock Telegraph Company, was perhaps the most serious contender against the Bell Company. The telephone instruments which the Western Union used were constructed on the plans of Edison and Gray and George M. Phelps, the then superintendent of the New York shop of the Western Union Company. Some of the telephone instruments were made in this shop and others in the shop of the Western Electric Manufacturing Company in Chicago. Many thousands of telephone instruments and numerous telephone switchboards were in use up to the time that the Bell Company began a suit on September 12, 1878, to be settled out of court on November 10, 1879, resulting in the withdrawal of Western Union interests from the telephone field.

There is one case full of exhibits of the American Speaking Telephone Company's apparatus, most of which was made in the Western Electric shop and some in the California Electrical Works shop in San Francisco, the Pacific Coast agent. The general appearance of these exhibits attests to the early reputation of the Western Electric Manufacturing Company as a manufacturer of the highest grade of electrical apparatus. Some of these instruments are shown in Figure 14.

Vacuum Tube Repeaters

The introduction of the vacuum tube repeater in the telephone plant has, perhaps, more than any other unit of apparatus, led to the rapid extension of wire and radio telephony. Its application in telephony began with the first use of a high vacuum three element tube as a telephone repeater at Phila-

delphia in the regular New York-Baltimore wire toll circuits on October 18, 1913, this being preliminary to their introduction in the transcontinental circuit from New York to San Francisco opened January 25, 1915. These were three electrode high vacuum thermionic tubes, first produced by Harold D. Arnold, from the basic three electrode audion, invented in 1906 by DeForest, one of the pioneers in radio.

During September and October of that same year, 1915, in wireless telephone tests the human voice was projected for the first time beyond this country, from Arlington, Virginia, to Paris, France, and to Honolulu, H. T.

The vacuum tube case shown in the front center of the frontispiece contains the exhibits portraying the more important stages of tube development.

Vacuum Tubes with Historical Associations

A model of the "Edison effect" of 1883 is followed by a model of the Elster and Gietel tube for the study of thermionic discharges and other early tubes of Von Lieben and Fleming previous to a sample of DeForest's three element tube of 1908. A sample of Arnold's mercury arc repeater of 1912 bridges the gap between the Shreeve mechanical and Arnold's high vacuum tube telephone repeater of 1913. There are a large number of laboratory experimental tubes from this time on, up to and including war time developments, 1917–1918, of our own and other American manufacturers as well as a number of European tubes of the war period. With the development of the seal between copper and glass the high power water cooled tubes came into existence in 1920. The experimental 4 KW tube of that date was a tremendous advance from the 25 watt air-cooled power tube in the 1915 transoceanic tests. Next came the 10 KW, and in 1922 an experimental 100 KW single-ended tube was constructed and tested. This tube preceded by many years the commercial 100 KW double-ended tube. A group of low voltage cathode ray oscillograph tubes are

shown as well as Davisson and Germer's electron defraction and polarization tubes of 1926–27. Among the tubes used in noteworthy events are: one of the 500 twenty-five watt air-cooled power tubes used in the Arlington-Paris-Honolulu tests of 1915; a 10 KW water-cooled tube used in the first sustained radio telephone talk across the Atlantic, January 23, 1923; a tube designed for and used in the radio airplane transmitter on Byrd's first successful flight across the North Pole, May 9, 1926; and an air radiation tube, 1 KW, used on the steamship Leviathan at the inauguration of ship-to-shore radio telephone service, December 8, 1929. A group of vacuum tube exhibits is shown in Figure 15.

Modern Vacuum Tubes and Photo-electric Cells

Adjacent to these historical tubes is a case containing a display of the various types of commercial vacuum tubes developed by the Laboratories for all the various parts of the telephone plant both wire and radio at the present time. There are some 70-odd tubes ranging in size from the small "peanut" type 2 11/16 inches high to the 100 KW amplifier 4 feet high. Photoelectric cells form an interesting group ranging from the small cell used in the transmission of photographs over telephone circuits in 1924, to the cells for sound film reproduction, and those used in our television demonstrations. The latter include cells used in the first one-way demonstration between Washington, D. C. and New York City by wire and between Whippany, New Jersey and New York City by wireless on April 7, 1927; the out-of-door demonstration June 12, 1928; the color television demonstration June 27, 1929; and the two-way television demonstration for a distance of over three miles beginning April 9, 1930, and lasting over two years. The associated neon lamps at the receiving ends are also shown.

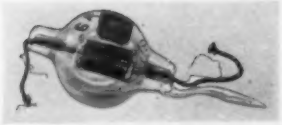
The Printing Telegraph

Printing telegraphy dates back almost to the beginning of the telegraph itself. Our earliest exhibit is that of the Gray printing telegraph of 1872 mentioned previously; other early machines include the Phelps set of 1872, the Essick page printer of 1891 as well as a Baudot (French) set of 1902. We have examples of Bell System developments of later dates but none are on display at present.

Microphones and Loud Speaking Receivers

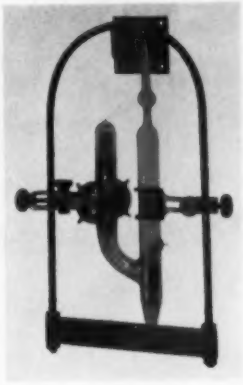
The developments of microphones and loud speaking receivers for public address, sound picture recording and reproduction and radio broadcasting are shown by numerous exhibits. The earliest microphone is an Ader, a loose carbon Hughes type, used at the Paris Exposition of 1881, where broadcasting by wire was demonstrated probably for the first time. Several of these transmitters were located around the front of the stage; half were connected to the head receivers for the left ears and half to the receivers for the right ears to produce the binaural effect. (Even before this time, Bell had experimented with his magneto telephones to produce this effect. His experiments were described in a monograph read before the American Association for the Advancement of Science at Saratoga, New York, in August, 1879.) Later on, the theatre transmitter with its wooden diaphragm and granular carbon button developed in the Bell Laboratories appeared in 1899. Condenser transmitters used at President Harding's inaugural in Washington and at the burial of the Unknown Soldier in Arlington, Virginia, in 1921, mark important steps in broadcasting transmitters. This type of transmitter has for many years served several useful purposes in the development and refinement of telephone instruments in general and in the field of broadcasting, loud speaking and sound picture technique in particular. Later steps are shown by the electro-dynamic

DeForest Three-element Tube: 1908.

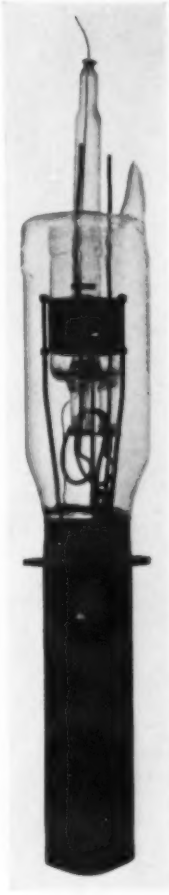


High Vacuum Telephone Repeater: 1913.

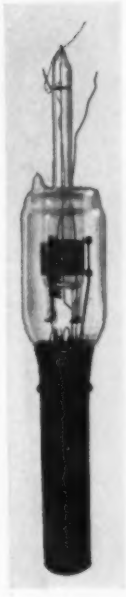
Modern Telephone Repeater: 1927.



Arnold Mercury Arc Repeater: 1912.

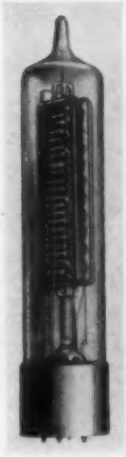


Experimental 100 Kw. Water-cooled Tube: 1922.



10 Kw. Water-cooled Tube: 1923.

25 Watt Air-cooled Power Tube for Trans-atlantic Tests: 1915.



1 Kw. Air-cooled Tube for Ship-to-Shore Telephone Service: 1929.

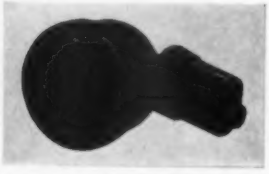
Low Voltage Cathode Ray Oscillograph Tube: 1922.

FIGURE 15

Ader Theater Microphone: 1881.

Bell Theater Microphone: 1899.

Condenser Transmitter Used at Inauguration of President Harding: 1921.

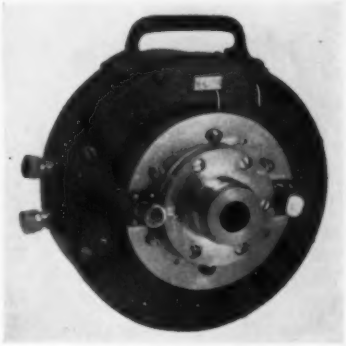


Electro-dynamic Microphone: 1931.

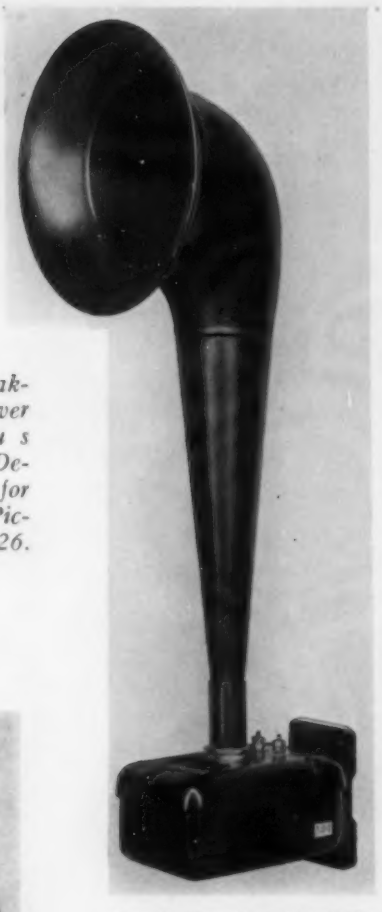
Non-directional Microphone: 1935.

FIGURE 16

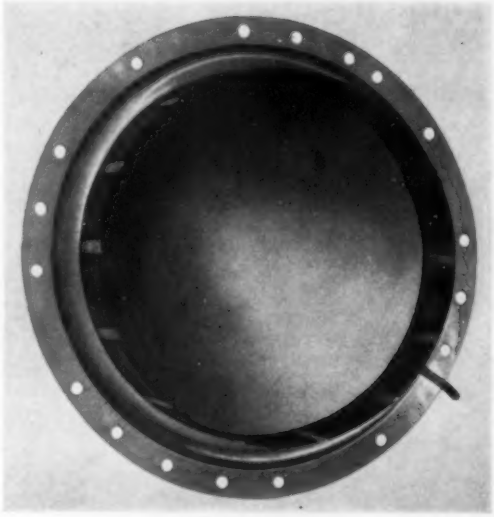
Loud Speaking Receiver Used at Harding Inaugural: 1921. (For Associated horn, see Figure 11.)

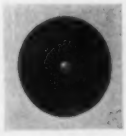


Loud Speaking Receiver (Minus Horn) Developed for Talking Pictures: 1926.



Loud Speaker Used in Paris on Transatlantic Tests: 1915.





Diaphragm of High Power Loud Speaker Used at International Yacht Races in 1934 (left) Compared with 196-Type Diaphragm of 1918 (right).

FIGURE 17

Replica of Transmitter-Receiver Used in First Long Distance Conversation, Between Boston and Cambridgeport, Mass., two miles: 1876.

Telephone Used in Talking Around the World, from and to New York City, 23,000 Miles: 1935.

FIGURE 18

transmitter of 1931 and the non-directional moving coil transmitter of 1935. There are also several samples of air-damped and stretched steel diaphragm transmitters of the 1916–1920 vintage. A few of these microphones are shown in Figure 16.

The loud speaking receiver development has kept pace with that for microphones. Among our more important exhibits are the No. 177 type loud speakers originally designed in 1911 for train dispatching, through which were heard in Paris the first words crossing the Atlantic by wireless in 1915; one of the eight No. 196 type balanced armature receivers (and its 10½ foot horn, shown at the left of the exhibit case, Figure 11) used at President Harding's inaugural in 1921; and a No. 555 type moving coil armature, which was developed primarily for use with the Vitaphone talking pictures, first publicly demonstrated August 7, 1926. The moving coil loud speakers have been further developed both for smaller sizes than the No. 555 and for much more powerful units. We have a sample moving coil diaphragm of the high power loud speaker first publicly demonstrated during the International Yacht Races off Newport, Rhode Island, in the fall of 1934. While we have purposely avoided comparative statistical data, exception can be made in this instance to give the performance of this powerful loud speaker. It is capable of a maximum sustained output of approximately 500 watts of sound, and it has a maximum conversion efficiency of approximately 60 per cent. Figure 17 shows some loud speakers and the comparative sizes of the diaphragms of a No. 196 receiver and that of the yacht race loud speaker of 1934.

War Time Developments

Another group of exhibits show some war-time developments during 1917–18. A complete short range radio telephone equipment for submarine chasers, type CW–938, is mounted on a large panel at the rear of the Museum. A complete airplane

telephone set, including the ground station, the first outfit to be developed, type SCR–68, is on exhibit in the first case on the extreme right in the frontispiece. Also, there are numerous wireless telegraph outfits, seaphones, submarine detectors, and Piezo crystal submarine detectors.

European Telephone Apparatus

A group of foreign telephone instruments was obtained prior to the time the International Telephone and Telegraph Company acquired the foreign interests of the Western Electric Company, and covers some interesting phases of the communication art outside the United States. We have two Bell hand telephones made in England and used at Osborne House, January 14, 1878, in a special demonstration conducted by Professor Bell for Her Majesty, Queen Victoria; the Ader theatre microphone of the type used in 1881 previously described; one of the two original Dr. Reith's receivers of 1877, similar to the Bell box telephones of that year; and later English, French, German, Swedish and Antwerp type telephone sets, the majority of which are equipped with the familiar European handsets. There is a small unit of a ten-line automatic telephone system designed at the Vatican in Rome and in use in 1886; it shows a very high grade of workmanship.

We have so far seen the developments of the communication art along more or less well defined paths. The ever widening scope of related activities in the electrical transmission of intelligence, some of which may be classified as by-products, are represented by a few examples of their essential elements.

Telephotograph Developments

The original light valve used in telephotographic reception on a photographic film in the series of experiments of 1923 leading up to the commercial Bell telephotograph system in 1924, is shown alongside of the commercial type of light valve

used in photographing sound records on film. The former valve was originally constructed for making experimental sound records on film in the laboratory. In Figure 6 the photographs on the wall show the developments of telephotography from the experimental work in May, 1923, on the left, to the latest telephotograph system inaugurated January 1, 1935, to transmit simultaneously an 11 x 17-inch photograph, on the right, to twenty-three different cities in the United States.

Talking Motion Pictures

During 1915, when the World's Fair was in progress in San Francisco, and demonstrations of the transcontinental telephone service were made between New York and that city, a talking motion picture of Thomas A. Watson, entitled "The Birth of the Telephone," was shown many times daily, by George K. Thompson and Wilton L. Richards of the Bell System exhibit staff. This was long before the electrical recording and reproduction on discs was developed for talking pictures as a by-product of the Laboratories' researches in telephone transmission problems. The talking part of this outfit consisted of a large Edison phonograph cylinder record used with an Edison phonograph that was located on the stage in front of the screen. Its synchronous operation with the film was effected by means of a silk fish line run over ball bearing pulleys to the hand-operated Powers film projector at the rear. This outfit is represented in the Museum by one of these cylinder records. A bone conduction receiver for deaf people, 1912, and an electromagnet receiver of 1924 with a cap molded to fit the contour of the user's ear, illustrate the early work of what are now known as audiphones. The first type of artificial larynx developed in 1925, Piezo electric developments with Rochelle salt crystals in 1919–20, frequency standards of tuning forks in 1922, and later of quartz crystals in 1927, and quartz crystal oscillators for radio transmitter frequency control in 1928, are

among the exhibits of many miscellaneous by-products. The high power microscopical work of the Laboratories is represented by photographs of high magnification of some of the metals used in our apparatus.

Along the south wall of the Museum is one of the radio telephone transmitters of the Long Beach-Catalina Island radio link, the first radio toll link in a commercial telephone system, opened for service July 16, 1920. On top of the transmitter there is a rotating condenser, an important element in the first privacy system for commercial radio telephone service which was added to this radio link on June 4, 1923. Shortly afterwards a submarine cable of much greater capacity was substituted for the radio system. Nearby is the revolving radio receiver loop used in London on the occasion of the first transatlantic radio speech from New York, one way, held on January 14, 1923. These exhibits are shown to the left of the exhibit case in Figure 11.

Instruments Used on Historical Occasions

A group of telephone instruments used in the ceremonies attending the opening of long distance telephone circuits makes one realize how the world has contracted from a communication standpoint. We see the desk set used in New York in opening the New York-Chicago telephone service in 1892; transmitters and receivers used in opening the lines from New York to Denver in 1911, and from New York to San Francisco in 1915; the transmitter at Arlington and the receivers at Paris and Honolulu, in the first transoceanic radio telephone tests in 1915, and the desk stands used in opening commercial radio telephone links to Europe and South America; and the latest, one of the telephone sets used in talking for the first time around the world, on April 25, 1935. At this demonstration, President Walter S. Gifford and Vice President T. G. Miller of the American Telephone and Telegraph Company talked to each other

in adjoining offices in the Long Lines Building, 32 6th Ave., New York City, over a circuit 23,000 miles in length.

The telephone set used by Mr. Gifford on this occasion was presented to the Smithsonian Institution; the one used by Mr. Miller is in our collection and is shown in Figure 18. Above this set appears a replica of one of the two transmitter-receivers used in the first long-distance two-way conversation, a distance of two miles, between Boston and Cambridgeport, Massachusetts, on October 9, 1876, nearly sixty years earlier.

Along the west wall of the Museum are three large panels of photographs, one covering the period of the experimental work and the introduction of the telephone on a commercial basis; another some research and development laboratories in the present Laboratories' building; and the third, interesting events of historical significance in connection with the extension of telephone service to cover practically the entire globe.

Our trip through the Museum has now been completed.

Its exhibits have presented a cross-section of the art of electrical communication and particularly of telephony. The Museum is growing with the art it attempts to record. Its choicest exhibits, however, will always be those of the early years. Relics of those years are gradually becoming less available; and the Museum, therefore, will be interested in any that are available. Through their display it aims to perpetuate the names and achievements of the inventors, engineers and scientists who laid the foundations of the still expanding arts of electrical communication.

W. C. F. FARNELL

Notes on Recent Occurrences

HARRY BATES THAYER

HARRY BATES THAYER, former President of the American Telephone and Telegraph Company, died at his home in New Canaan, Conn., on September 3 after a long illness. He was the predecessor of Walter S. Gifford as President of the Company, serving in that post from 1919 to 1925, when he became Chairman. Upon his own request he retired to private life upon his seventieth birthday, on August 17, 1928.

Harry Bates Thayer was a New Englander. He was descended from John Alden, Governor Brewster and other New England settlers and was born at Northfield, Vt., on August 17, 1858, the son of James Carey Barrell and Martha Jane (Pratt) Thayer. After studying in the public schools of Northfield and at Norwich University, he entered Dartmouth College, from which he was graduated in 1879. His first job after graduation was that of a railway clerk in Bellows Falls, Vt. Later he became a clerk in a Northfield savings bank.

His association with the Bell System began in 1881 and extended over almost half a century. He started as a shipping clerk for the Western Electric Company in Chicago and his salary was $10 a week. However, his ability to get things accomplished—for which he was later to become so well-known in the Bell System—must have early manifested itself, for in 1884, at the age of twenty-six, he was made Manager of the Western Electric Company's business in New York. He served as Manager from 1884 to 1902, as Vice-President from 1902 to 1908, and as President from 1908 to 1919. In 1909 he was elected Vice-President of the American Telephone and Telegraph Company, a position which he relinquished along with

the presidency of the Western Electric Company when he became head of the A. T. & T. in 1919.

Mr. Thayer's association with the business covered a period of great growth. The electrical industry, at the time he entered the Western Electric Company, was truly in its infancy. Of the present great public services based upon the use of electricity, only the telegraph was commercially well established. Arc lighting as a commercial enterprise was only a few years old. Lighting by incandescent lamps had not commenced. In the Bell System there were less than 50,000 telephone subscribers. During Mr. Thayer's connection with the Bell System the plant investment rose from $25,000,000 to more than $3,500,000,000.

The minutes of the meeting of the Directors of the American Telephone and Telegraph Company, held on September 16, 1936, contain the following:

"This meeting records with sorrow the death on September 3, 1936, of Harry B. Thayer, one of the outstanding personalities in the development of the Bell Telephone System.

"Starting as a shipping clerk in the Western Electric Company in 1881, he became the President of that Company in 1908 and served in that capacity until 1919, when he was elected President of the American Telephone and Telegraph Company. In this position and later as Chairman he served until, at his own request, he was retired on his seventieth birthday, August 17, 1928. His contributions to the extension of telephone service in the United States, to the perfection of that service and to the development of morale and efficiency among the personnel of the Bell System were major and marked. Through his kindly personality he contributed much to the happiness of all who were associated with him and to their satisfaction in the work done under his leadership."

DR. COLPITTS TO BE IWADARE LECTURER

DR. EDWIN H. COLPITTS, Vice-President of the Bell Telephone Laboratories, has been chosen as the fifth lecturer to visit Japan in accordance with the terms of the Iwadare Foundation. The invitation, which was tendered by the

Japanese Institute of Electrical Engineers, reached Dr. Colpitts in July and specified four weeks of next spring as the period during which the addresses are to be made.

The Iwadare Foundation is so called because of the gift in 1929 of yen 500,000 to the Japanese Institute of Electrical Engineers by Mr. Kunihito Iwadare, who was for many years Managing Director of the Nippon Electric Company, which had been organized in 1899 as a joint undertaking with the Western Electric Company for the development of telephony in Japan and for the manufacture of communication equipment. The principal of the gift is held as a trust fund and half of the income pays the expenses of selected Japanese students of electrical engineering for graduate study in the United States. The other half of the income pays the expenses of distinguished electrical engineers who are invited to give a series of lectures at various Japanese universities.

SEVENTH REDUCTION IN LONG DISTANCE RATES IN PAST TEN YEARS

THE seventh rate reduction in ten years affecting interstate long distance calls was instituted by the American Telephone and Telegraph Company on September 1. Savings to long distance users from this reduction are estimated at $6,000,000 annually. In addition, similar rate reductions to be made by many of the Associated Companies of the Bell System will bring the total savings to the public to more than $7,350,000 a year.

The new rates reduce the cost of long distance calls for distances of more than 234 miles. In addition, the overtime charges on all person-to-person calls after six minutes of conversation are the same as station-to-station overtime charges for the same distances. This reduction effects a saving of as much as twenty per cent in some calls.